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THE MINERALOGICAL MAGAZINE

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No. 193 June, 1946 Vol. XXVII

An improved polarizing microscope.

By A. F. Hallimond, M.A., Sc.D., F.G.S.

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Messrs. Cooke, Troughton, and Simms, Ltd., York.

[Read March 28, 1946.]

I. *Introduction.*

In recent years there has been little essential change in the design of the petrological microscope. F. E. Wright[2] directed attention to the improvement that could be obtained by using a full-sized condenser with a large polarizer, but the high cost of the latter seems to have restricted its use to a few special models.

With the introduction of 'polaroid', a thin, intensely pleochroic film mounted between glass disks, this restriction no longer holds. A polarizer can be supplied of sufficient size to cover an ordinary Abbe condenser, while the analyser no longer requires the compensating lenses which usually accompany a calcite prism, with the indirect result that the definition of the interference-figure is improved.

The microscope now to be described has been designed to give effect to these changes. In considering the requirements of petrologists much help has been derived from two reports issued by the Petrological Microscope Committee, which was instituted by the Mineralogical Society and the Geological Society of London. These recommendations, while leaving open the actual design, provide a very helpful account of the equipment now regarded as essential for research and teaching. A further condition is that the instrument should be produced with due regard to economy in price, and for this purpose it is advantageous to utilize a model already in production. Fortunately it has been possible to adapt with the minimum of alteration a recently designed biological stand (Cooke, Troughton, and Simms M1000 series). The resulting instrument possesses the quality and accuracy necessary for all ordinary research work, but it will not accommodate the existing large models of the universal stage. On the optical

[1] Published by permission of the Director, Geological Survey and Museum.

[2] F. E. Wright, The methods of petrographic-microscopic research. Carnegie Inst. Washington, 1911, Publication 158.

side the present arrangement seems quite suitable for universal stage researc
it is clear, however, that any adequate instrument designed to accommodate t
largest stages must have a specially large stand, and relatively few examples w

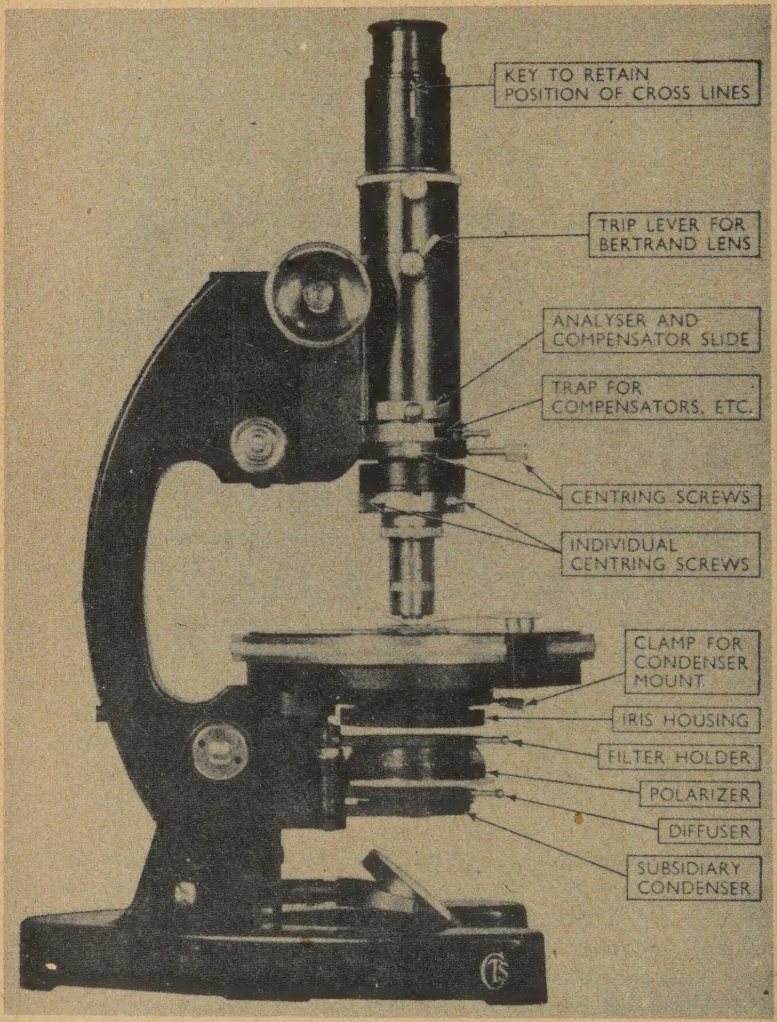

FIG. 1. Improved polarizing microscope.

be required; its cost will presumably be therefore substantially greater than th
of the model here described.

The general arrangement of the instrument is illustrated in figs. 1 and
Commonly accepted dimensions have been adopted for the stage, tube slots, &
so that many existing compensators and other accessory apparatus can be us
and provision has been made for wide-angle eyepieces. A standard reflector un
which can be inserted without increasing the tube length, renders the instrume

vailable for ore-microscopy. The Bertrand lens[1] is of special design, which iminates the need for refocusing the objective in order to form an image upon ıe Bertrand diaphragm.

II. *The stand.*

The foot, limb, and focusing movements are of standard biological pattern, hile the stage, substage, and tube have been designed for petrological work.

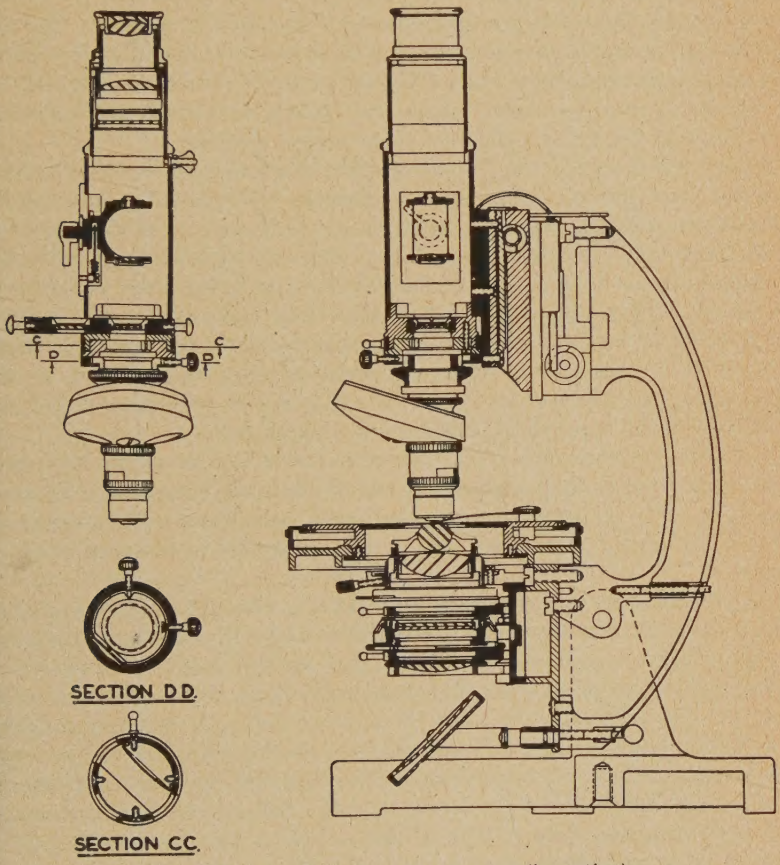

Fig. 2. Improved polarizing microscope (in section).

wo additional projections under the foot, while not normally touching the ench, prevent the microscope from being readily overturned. The hinge gives eat stability in all positions, and a lock has not been thought necessary. The ıe adjustment reads to 0·002 mm. and is sprung so as to relieve the pressure the objective touches the cover-glass.

III. *The substage.*

Before the advent of polarizing film substage design was largely determined r the small size of the calcite prism. The condenser rarely exceeded ½ inch in

[1] The Bertrand lens described is covered by British Patent Application No. 24755/44, which controlled by the Department of Scientific and Industrial Research.

diameter, and elaborate optical arrangements were used to make the best of rather poor conditions of illumination provided. With such a condenser the fi was restricted to about 0·5 cm.; the wider fields required for the lower pov objectives could only be obtained by removing either the whole or the up part of the condenser whenever these were brought into use.

The present substage is shown in part section in fig. 2. The condenser is o standard Abbe type, giving N.A. 1·25 when immersed in oil, and is retained a sleeve at the desired height by means of a strong locking-screw. The fiel wide enough to supply all objectives up to $1\frac{1}{2}$ inches. On changing objectives only adjustment required is that of the aperture iris. With the large conden the adjustable centring-screws, which were mainly concerned with centring small image of the calcite polarizer, are no longer required.

Wright[1] has discussed the polarizing effect of glass surfaces for rays inci obliquely. Such incidence occurs in all condensers, dry object-slips, and objectiv and produces a certain degree of rotation in the quadrants of the interferen figure, the general effect being as though a very weakly positive crystal had be interposed. It has been suggested that the surfaces in an Abbe condenser m be specially liable to this action, but it seems clear that any such result can o be a question of degree in an effect which is never likely to be absent. With microscopes, for minerals of extremely weak birefringence, reliance should placed upon direct measurements of the sign made on a section of the crys and not upon the appearance of the interference-figure.

Below the condenser is a screen-holder in which can be placed dark-grou stops, colour screens, or apertometer scales visible in the interference-figure. T gypsum or other compensators sometimes used here would now be rather la and it is probably better to use smaller plates inserted in the tube slots in usual way.

The polarizer is a disk incorporating polarizing film, rotatable in a graduat swing-out mount with arrests at 0° and 90°. Under it is a screen-holder wh normally carries a ground-glass diffuser, and another holder containing a lo power auxiliary collective lens. These are particularly useful when the source light is narrow or distant. To cover the required field and to supply an apert up to 1·4 N.A. it has hitherto been necessary to employ a large area of sky a lamp brought close to the microscope. The collective lens now used supplies effect a magnified image of the source, and the diffuser eliminates the image window-frames, &c. Very fair illumination can, in fact, be obtained from ordinary 100-watt bulb at about a yard from the microscope, although a hi intensity lamp is recommended for general purposes.

All the lower components are mounted in separate swing-out fittings and be displaced so as to permit the immediate removal of the condenser for application of oil, &c.

IV. *Illumination.*

It has been usual to define critical illumination as the supply of light when image of the source is formed by the condenser either in the plane of the obj or, in practice, slightly above or below that level. From another standpoint, t

[1] F. E. Wright, The formation of interference figures. . . . Journ. Optical Soc. Amer., 19 vol. 7, p. 779. [M.A. 2–369.]

the efficient working of the objective, the condition usually desired is that the rrect working aperture should be uniformly filled with light for every point in e visible field.

The first of these definitions can only be verified by examining the image of the ge of the source or of a mark (if present) in its surface, which is otherwise distinguishable. A perfectly uniform source will emit light equally in all the quired directions, and conditions above the condenser will be as indicated in . 3. The image of a point p in the source will be formed by the conical beam dicated by darker lines at the point p'. The plane aa' contains the image of e source, but, as has been said, there is nothing to distinguish this image unless e source is irregular. When both the ld (in aa') and the aperture (interfer- ce-figure) are uniformly illuminated e whole central region above the con- nser can be regarded as illuminated intersecting parallel beams derived om points in the lower focal plane of e condenser. Under these conditions e lighting at a point q above or below will be substantially the same as at . The object may therefore be placed any point in the central region. In e present microscope, when the ffuser is in position, the image of the urce is completely suppressed. There no special 'aplanatic cone' in the cen- ıl region. Defects in the correction of e condenser, and lack of achromatism, affect chiefly the conditions at the undary of the field, while the central region will still give sufficiently good umination. With the large condenser a mounting slip of any ordinary thickness n be used without refocusing the condenser, and a substage focusing rack is not nsidered necessary.

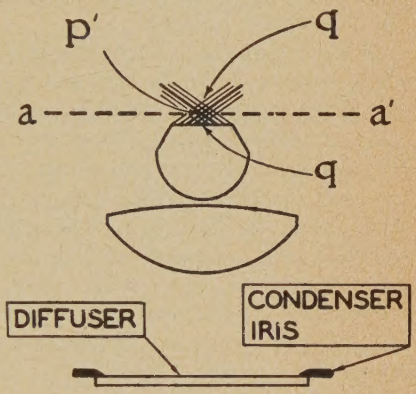

FIG. 3. Illumination by an Abbe condenser with diffuser.

Flat and concave mirrors of the usual type have been provided; it should be ted, however, that the large condenser now employed requires a much wider am than the prism polarizer. The diffuser should be uniformly illuminated er a width of about one inch, and this is usually best obtained by using the t mirror with light from a bright source which need not be specially large. ith very low-power objectives, and for photography with low powers, the ndenser should be removed and the ground glass arranged to supply a uniform d.

When very strong lighting is required, e.g. for a weak interference-figure, or the spectroscope, the diffuser should be removed and an image of the source used on the object in the usual way, by locking the condenser at the required ght. A field iris, if required, can be used either on the lamp or in an eyepiece.

V. *The stage.*

The design follows ordinary practice, with a substantial milled edge, the meter being 12 cm. Wider stages become inconvenient for routine work on

account of the larger hand movement required in making the rotation. C vernier is provided, reading to 0·1°, and there is a removable ring-plate.

VI. *The tube.*

Considerable changes have been introduced, including a new Bertrand le fitting.

(1) Eyepieces.—The usual wide and narrow field types are available, and t range of focusing has been extended to permit the focusing of compensators the slotted objective when the Bertrand lens is in position.

(2) Eyepiece tube.—Tubes for wide and narrow eyepieces are interchangea by a removable bayonet head, which also gives access to the Bertrand lens fitti The drawtube is omitted.

(3) Bertrand lens.—The customary slide has been replaced by a rotary fitti which remains within the tube and is completely dust-proof. A serious disadva tage of the ordinary Bertrand arrangement has been the need for refocusing t image to coincide with the diaphragm, which was placed immediately above t Bertrand lens. This image is normally situated about 2·5 cm. above the Bertra lens, and the present fitting comprises a single rotary holder which carries bo the lens and the diaphragm at the proper distance above it. When the holder rotated to the horizontal position the lens and diaphragm move to the sides the tube and the centre is left clear. An adjustable screw stop on the hold ensures that the Bertrand lens coincides with the axis of the microscope, and t diaphragm is also in an adjustable plate by which it is brought to include t centre of the image. No iris is provided, since the centre of the field can identified without difficulty by inspecting the diaphragm with a hand-lens wh the eyepiece tube is removed. The diameter of the diaphragm opening has be chosen to cover an area of 0·05 mm. diameter on the object when the $\frac{1}{6}$-in objective is in use. This is rather larger than the extreme minimum claimed the older Bertrand fittings, but the loss of light and difficulty in centring beco very marked for the smallest openings. The present diameter is about twice t thickness of a rock section.

As has been said, the initial adjustment of the present Bertrand fitting sho ensure that the interference-figure is centred to the cross-wires of the eyepie Hand-centring movements on the Bertrand lens have been omitted. With t present larger condenser it may be useful to follow Wright's procedure and ins an aperture scale and cross-lines in the screen-holder immediately below the co denser, so that they are visible in the interference-figure.

(4) The analyser.—With polarizing film this is simply a thin double glass d mounted in a sliding holder of the usual type; a rotating mount with a moveme through rather more than 90° can be supplied, but is not always needed. T compensating lenses are no longer required, but a disk of clear glass is mount in the opening usually left vacant; this compensates for the change in foc otherwise due to the thickness of the analyser plate.

(5) Tube slots.—These are of standard size, capable of taking the Berek co pensator, and are protected by the usual sliding cover (section cc, fig. 2).

(6) Centring movement.—In several recent microscopes this has been omitte it is, however, of considerable service. For example, the centre is never exac the same after the tube has been raised to accommodate a thick polished spe

en; any small correction required can be applied by the hand-centring screws thout disturbing the adjustment of the objective holders or collars. A new sign has been adopted, in which the centring movements are approximately rallel with the cross-wires (section DD, fig. 2).

(7) Objective changers.—A standard precision objective-changing clutch with ntring collars is available alternatively with a rotary changer.

VII. *Ore-microscopy.*

The ordinary cover-glass reflector, though optically the most satisfactory, gives o weak a reflection for use with polarized light, and a prism has usually been pplied interchangeably. Cover-glasses are now available with highly reflecting atings, the results being comparable with those for a prism, with the advantage employing the full aperture of the objective. Both cover-glasses and prism ually have a polarizing action, and special devices have been introduced to oid this in apparatus which is to be employed for the measurement of bire-ction. On this question reference should be made to the work of M. Berek[1] and L. Capdecomme and J. Orcel.[2] The latter authors have proposed to utilize the egularity in field due to this polarizing action for determinative purposes. ith this object a reflector of ordinary type may be retained, while for photo-aphy, or other purposes that require uniform extinction over the whole field, e anisotropy is neutralized by the insertion of a sheet of mica before the flector.

For ordinary determinative work a special simple reflector unit is available gs. 4 and 5), provided with a coated cover-glass and attachable to the tube by objective screw. It can be inserted without increasing the tube length, so that dinary objectives can be used, if desired, with reflected light. When the micro-ope is to be used for transmitted light the reflector unit need not be removed: is sufficient for general purposes to turn the cover-glass to the horizontal sition; it must not, however, be left inclined, on account of its polarizing action. No stage rack is provided, but a special rising centre fitting (superstage) has en designed, similar in purpose to the 'mushroom stage'. The latter, which is tached to the substage rack, has the disadvantage of being rather unstable in nstruction, while only a small independent divided circle is employed. The esent device has a similar range of vertical movement, but readings are taken the main circle of the microscope stage, and the centre of rotation is still the is of the microscope. The fitting is attached by swinging out the substage tings and removing the condenser; the central tube of the superstage is then serted in the stage opening and the plate is fixed to the stage by two screw-heads.

Conventional orientation of the polarizer.—For transmitted light the general ndency in recent years has been to prefer a N.–S. vibration-direction for the larizer. There are, however, no very strong physical reasons for this.[3] When eflector unit is in use the most efficient illumination is obtained if the polarizer

[1] M. Berek, Optische Messmethoden im polarisierten Auflicht.... Fortschr. Min. Krist. Petr., 37, vol. 22, p. 1. [M.A. 7-250.]

[2] L. Capdecomme and J. Orcel, Détermination des propriétés optiques des cristaux aques. . . . Revue d'Optique théorique et instrumentale, 1941, vol. 20, p. 47.

[3] F. E. Wright, The position of the vibration plane of the polarizer in the petrographic croscope. Journ. Washington Acad. Sci., 1915, vol. 5, p. 641.

is set so that the vibration-direction is in the plane of the reflecting surfa
Consequently, when the lamp is in front of the microscope the reflected beam
to be extinguished by setting the analyser at the N.–S. position. With a fix
analyser this position must be retained for transmitted light also, in which c
the vibration-direction of the substage polarizer will require to be E.–W. T
has therefore been adopted as the normal position, as in many English microscop

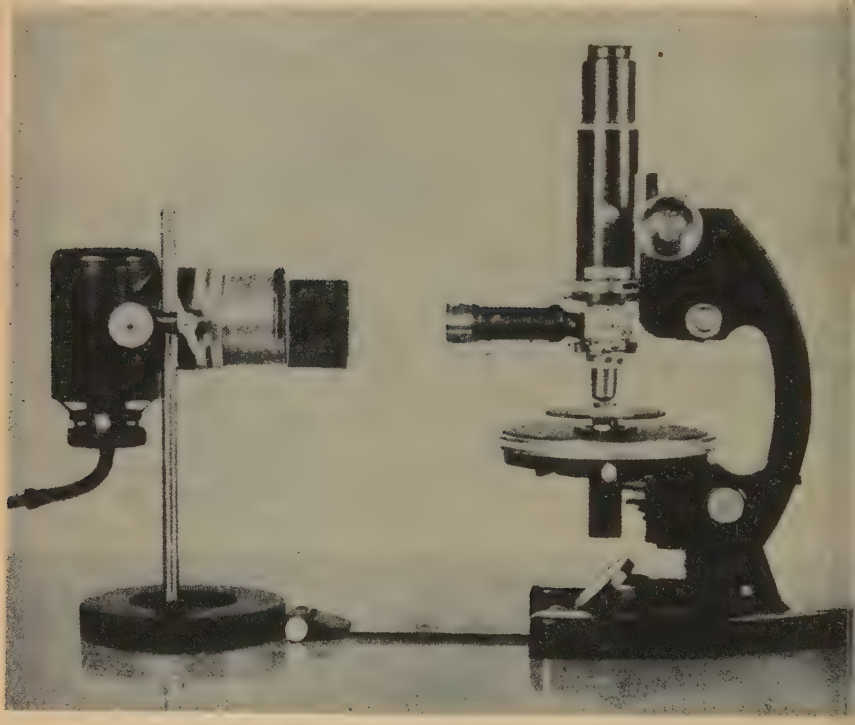

Fig. 4. Microscope with reflector, superstage, and lamp for ore-microscopy.

Adjustment of the reflector unit.—(1) With transmitted light in many mic
scopes the condenser or the ground glass of the lamp is focused on the obje
but for reflected light the lamp is used without a ground glass. The image
the filament is then to be focused on the field iris at the front of the reflect
and so upon the object, while the condenser iris is seen in the interference-fig
and serves as aperture iris.

(2) The cover-glass must, of course, be symmetrically mounted so that
surface, when in the position of use, is normal to the plane containing the a
of the microscope and that of the reflector tube. This setting is permanent
made and is unlikely to be disturbed in ordinary use.

(3) It is convenient to use a fixed analyser and to adjust the axis of the reflect
tube to coincide with a principal plane of the analyser. An isotropic polish
object is examined in a strong light, with the reflector unit in approximately t
correct position. The polarizer should then be displaced a little to either side

e 'extinction' position. The field usually appears yellow for one direction of e displacement and blue for the other, thus indicating lack of coincidence with e symmetry plane of the analyser. If the reflector unit is now rotated slightly out the microscope axis a position can be found by trial in which these tints

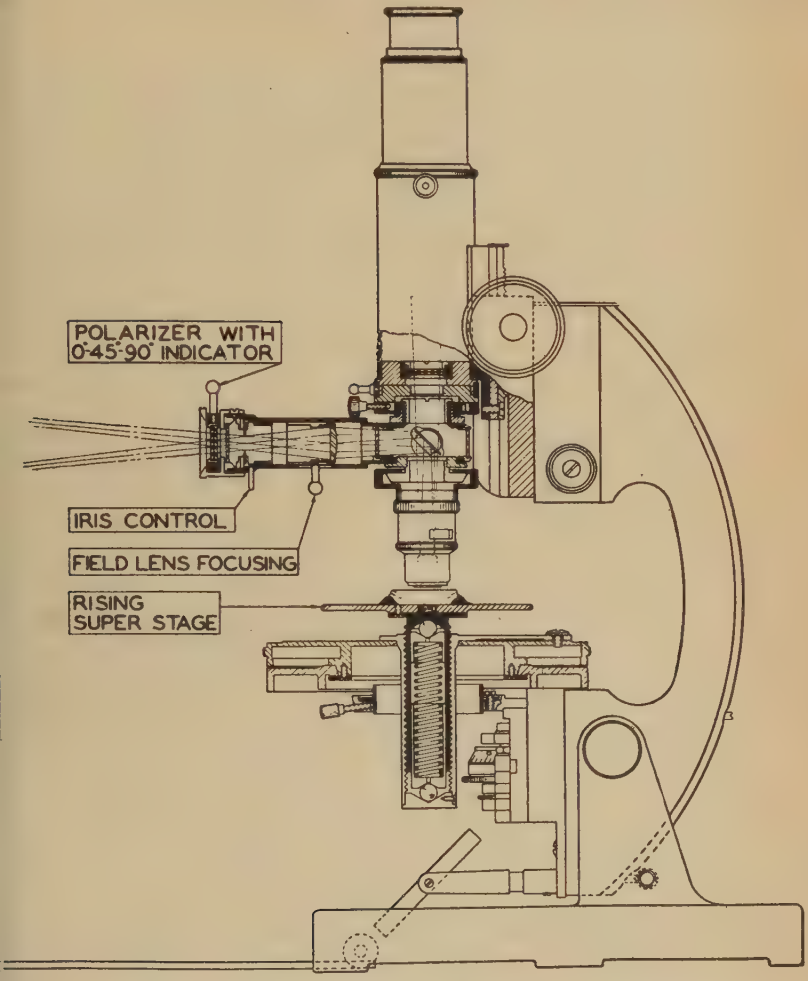

Fig. 5. Microscope with vertical illuminator and rising centre to stage (part section).

e absent, any colour seen being the same on both sides and due to the mineral ed. With a very strong light the same effects are visible within the field on ther side of a dark band which can be adjusted to the centre of the field (Capde- mme and Orcel, loc. cit., p. 69). Further accuracy in setting can often be tained by the stauroscopic method, using the interference-figure, and for special rposes the use of a Nakamura plate has been proposed, but this requires to be serted in the ocular. When the true extinction position has been found the ur extinction-directions at 90° can be verified in monochromatic light on a

bireflecting mineral such as stibnite, and the colour effects due to dispersion in the extinction or of the bireflection can be well seen.

VIII. *Accessory apparatus.*

The following equipment is recommended:
Slotted objective.
Graduated quartz-wedge.
Sensitive tint and ¼-wave compensators for the tube slots.
Nakamura biquartz plate (if great accuracy is required in measuring extinctions).
Light filters, including photomicro. green, and plain glass circles.
'Spot' stops for dark-ground illumination, and apertometer scale with cross lines.
Micrometer eyepiece.
Stage micrometer.
Reflector unit.
Superstage for ore-microscopy.

IX. *Outline of determinative methods.*

Many procedures have been devised for the measurements commonly undertaken with the petrological microscope. They are fully described in the text-books, and the present outline is intended merely to indicate a group of methods which are likely to yield the most satisfactory results with the present microscope.

(1) *Thickness.*—This is best measured with an objective of wide aperture and fairly high power, to reduce the depth of focus. Readings for the upper and lower surfaces of the grain are taken with the fine focusing adjustment. The apparent thickness must, of course, be corrected for the refractive index of the crystal.

(2) *Refractive index.*—Approximate values can be obtained by reading the apparent thickness of the mineral and the apparent thickness of a neighbouring grain of known refractive index, the readings being inversely as the refractive indices. If the crushed mineral is available liquid immersion methods are, of course, preferred.

(3) *Birefringence.*—Although compensators like that of M. Berek afford probably the most convenient means of determining the birefringence, the graduated quartz-wedge is also sufficiently accurate and has the merit of cheapness. In many microscopes the tube slots are too high to be focused by the Bertrand lens and slotted oculars are not always available. It has then been almost impossible to use the quartz-wedge, but this difficulty has now been overcome by the use of the slotted objective, introduced by Messrs. Cooke, Troughton, and Simms. The tubular section of a ⅛th-inch objective, above the lenses, is provided with slots of standard size, through which a compensator can be inserted just above the interference-figure. The graduations of the wedge are read by means of the Bertrand lens, with slight refocusing of the eyepiece. Wright introduced wedges in which a parallel compensating plate was mounted under the wedge, so that the zero (black) band appeared within the end of the wedge. The same result is obtained with the present microscope by placing a first-order compensator in the tube slots and then orientating the objective slots so that the wedge is in the compensating position; the zero band is then seen near the end of the wedge

Birefringence can only be measured accurately in parallel light. In the present
se the compensation is made over the central part of the interference-figure,
ich is formed by rays nearly normal to the section. By closing the condenser
the central circle can be isolated and very accurate settings of the compensa-
n band can be made, either to the cross-wires of the eyepiece or to a cross
erted in the screen-holder below the condenser and so visible in the inter-
ence-figure. The zero band is afterwards read with no object present. A calibra-
n scale should be prepared for the wedge by reading the interference-bands
ible in sodium-light between crossed, and parallel, polarizers. A great advantage
this method is that the intensity of the light is not reduced when the condenser
is closed, although the image in a slotted eyepiece is much weakened under
same conditions.

4) *Extinction.*—(*a*) For general purposes the 'stauroscopic' method of setting
dark band (isogyre) to cross the centre of the interference-figure is often
ficiently accurate. A strong light should be used, with a narrow opening of
condenser iris.

b) In a few cases, where the isogyre is too broad to be adjusted in this way
g., near a bisectrix), a Nakamura quartz plate can be inserted in the objective
ts with its boundary across the centre of the interference-figure.

c) Higher accuracy can only be expected when the aperture is still further
uced. The half-shadow plate must then be inserted in the image plane of the
ular. For this purpose an ocular of the Wright type is necessary, but the
thods (*a*) and (*b*) will probably suffice for all ordinary determinative work.

X. *Alternative simple equipment.*

For those who require polarizing equipment adaptable to the standard biological
roscope a substage unit has been designed to fit into the ordinary condenser
der. It consists of a tube carrying the standard condenser, aperture iris,
atable polarizer, and a recess for a ground-glass diffuser or light filter. With
polarizer at the zero position it should be adjusted in the condenser holder
give extinction with the analyser, and to focus the image of the lamp condenser
the object.

The analyser is of the 'cap' type, rotatable or fixed, and is to be attached to
top of the eyepiece tube. Since a glass disk with polarizing film is employed,
thickness is considerably less than that of a calcite prism.

There is no Bertrand lens, but interference-figures can be observed by removing
eyepiece. Since the optical scheme is substantially the same as that already
cribed, such an instrument can give very satisfactory results where speed in
nipulation is not of the first importance.

A contribution to the study of luxullianite.

By Maurice Kingsley Wells, B.Sc., F.G.S.

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[Read November 1, 1945.]

LUXULLIANITE is well known, at least by name, in this country, and in it enjoys an international reputation among petrologists. Its ge characters have been described by Bonney[1] and Sir John Flett,[2] while refere to the type is to be found in most standard text-books on petrology. It is, h ever, a rock of outstanding interest and deserves fuller description and illus tion than have yet been accorded it.

The preparation by Mr. A. V. Weatherhead of a large set of thin section s teaching purposes has given the writer an opportunity of making a more deta examination of the micropetrology of the rock, with special reference to manner of the replacement of the several original components. The partic specimen described was collected by Prof. W. T. Gordon from a loose bou near Luxullian in Cornwall. It contains rather fewer porphyritic felspars t normally, and these are light pink to cream in colour.

The rock is regarded as the product of the arrested pneumatolytic modificat by boric emanations, of a porphyritic alkali-granite of normal West of Engl type. The three essential components are microperthitic felspar, tourmaline, quartz, with apatite of two types, zircon, and a little rather dubious to accompanying them as accessories. The individual minerals are described fi The second part is an analysis of the various processes involved in the 'pr matolysis' of the rock.

Component minerals.

Felspar.—This is the only essential mineral that is wholly pre-pneumatoly It occurs as large, pink, corroded phenocrysts, often twinned on the Carlsbad l In thin section it is difficult to find a patch free from cloudy decomposition p ducts, but the microperthitic structure can still be seen as a small-scale ge blotchiness, rather than clearly defined areas of albite in orthoclase. That s corrosion has occurred is obvious from the shapes of the relics that have survi and the interest lies in the manner of the replacement. The inward limi penetration by the reactive agents is invariably an intricately sutured bound (figs. 1 and 2), usually obvious enough in plane polarized light by reason of cloudiness of the felspar, contrasting with the clearness of the quartz; but so times it is invisible, as the quartz, which fills great embayments in the felsp is as densely charged with inclusions as the latter. The inclusions in this have been merely by-passed. Elsewhere, by a curious contrast, the felspar been cleared of impurities in advance of the invading silica. Penetration has b most successful along cleavages, and the outlines of the embayments are in de

[1] T. G. Bonney, Min. Mag., 1877, vol. 1, p. 215.

[2] J. S. Flett, in The geology of the country around Bodmin and St. Austell. Mem. G Surv. England and Wales, Sheet 347, 1909, p. 66.

trolled by the latter, giving a complex, geometrical type of 'coastline'. The ginal, pre-corrosion boundaries of the felspars are less easy to see; but rounding some of the relics are zones of minute inclusions lying in the invasive rtz mosaic, quite independent of the shapes of the component grains of quartz, evidently related to the felspar (fig. 1). These shadow-boundaries show the -time euhedrism of the phenocrysts, and such marginal replacement is the stage in the elimination of the felspar. At a later stage the latter is reduced to an archipelago of islets in optical parallelism, set in a sea of quartz (fig. 3). ally, only concentrations of undigested impurities survive.

uartz.—It has not proved practicable to distinguish between the primary and pneumatolytic quartz, though some grains show the characteristic arcuate

Fig. 1.

Fig. 2.

g. 1. A much-corroded microperthite crystal, invaded by quartz mosaic. Original boun-es outlined by minute inclusions. Sections of two conical segments of tourmaline radial egate attached to later growths of euhedral, zoned tourmaline (top right, vertical section; om right, slightly skewed horizontal section). ×20.

g. 2. Microperthite, top left and bottom right, corroded and replaced by quartz mosiac ring pseudochalcedonic structure. The boundaries of the individual grains in heavy out-, and of the bladed segments shown by lighter lines. Imperfect stellate aggregates of tour-ne in the quartz. ×20.

s of minute gaseous and fluid inclusions—these may well be original—while which has demonstrably replaced felspar is clearly pneumatolytic. The eral shows differences in habit, proving it to have originated at different es, under varying conditions. A noteworthy feature of many of the sections ne large number of perfectly euhedral prisms occurring, sometimes in the maline 'felt' described below, and sometimes in quartz with a different cal orientation and of later growth (figs. 4 and 9 respectively). Such crystals hose shown in fig. 4 are important as demonstrating the fact that some of the tz preceded the secondary tourmaline; but some of it is definitely post-maline, proving that the period of quartz formation overlapped that of maline at both ends of the time-scale.

ne nature of the quartz mosaic may be judged from figs. 1, 2, and 9, in which boundaries of the individual grains, as seen between crossed nicols, have been

inserted. Once again it may be noted that, even in the mosaic, straight ed between adjacent grains are very common. Certain long, tenuous crystals o in veins of special significance, considered below.

Although their exact nature remains in doubt, reference may be made to cer 'chloritic patches' which have exerted some control over the crystallization of quartz. These are polygonal in shape, surrounded by quartz, there being as m grains as there are sides to the polygons, the boundaries of the grains running symmetrically from the corners. Concentric with the sides of the chloritic a are narrow bands of minute inclusions giving a ghost-crystal effect (fig. 3).

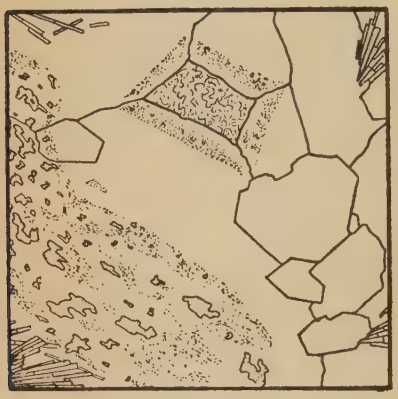

Fig. 3.

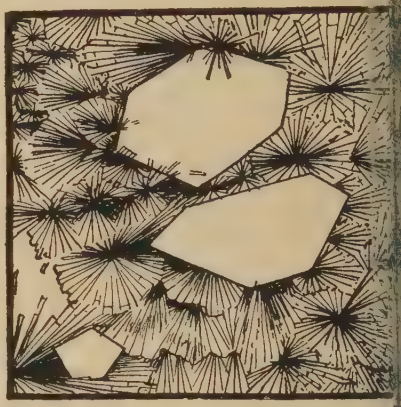

Fig. 4.

Fig. 3. Detail of quartz mosaic showing subhedral grains, some with zones of mi inclusions concentrically disposed about 'chloritic areas'. In the lower left-hand corner archipelago of optically alined islets of microperthite in quartz, representing the penultim stage in elimination of felspar. ×22.

Fig. 4. Detail of tourmaline 'felt' of closely packed radial aggregates containing ear euhedral quartz crystals. ×22.

The quartz which has demonstrably replaced felspar shows one curious p nomenon between crossed nicols. The larger grains of the mosaic are themsel in part minutely composite, being segmented, or, in extreme cases, minu bladed in a manner reminiscent of some forms of chalcedony. The boundaries the pseudochalcedonic areas are quite independent of those of the larger gra affected, but are obviously related to the quartz-felspar boundaries (fig. 2). T suggests that the phenomenon is due to strains set up at these boundari probably during cooling, and is related to the intimate interlocking of the minerals hereabouts.

Tourmaline.—As noted by earlier writers, the rock contains tourmaline of t generations, distinguished by differences in crystal habit and optical characte The earlier type occurs as relatively large crystals or irregular masses mai yellow in thin section: the later type consists of delicate green prisms. T yellow tourmaline forms relatively massive hexagonal or trigonal prisms oft much embayed by corrosion, and is therefore judged to be primary. The ends the prisms have often suffered most, and basal sections occur consisting of optica parallel, isolated, and quite shapeless masses, bearing no relation whatever to t

ape of the original prism (fig. 5). Strong colour-zoning is exhibited by the mary tourmaline according to the following scheme:

Core.	Outer zone.	Thin margin.
ϵ...very pale buff, nearly colourless	pale buff	darker buff
ω...very pale yellow	dull orange	light indigo

Absorption is, of course, much less for ϵ than for ω. A birefringence of 0·032 asured with the Berek compensator indicates a composition near schorlite inchell).

Fig. 5.

Fig. 6.

IG. 5. Much-corroded primary tourmaline with solid reaction border passing out into al aggregate. ×18.

IG. 6. A typical field showing abrupt termination of tourmaline prisms against ghost-ndaries; two generations of apatite, one pre-pneumatolytic, with dark cores (top left, ical sections; top right, basal section). ×18.

Bonney believed that the original granite contained biotite as an essential nponent, and that replacement followed the order:—biotite into yellow tourma-, and the latter into green tourmaline; but in none of the present set of slides any trace of biotite been found. Brammall[1] has already described certain es of the Dartmoor granite in which tourmaline has taken over a primary , and this appears to be the case in luxullianite.

The green pneumatolytic tourmaline is the mineral that has made the rock ious. It forms perhaps the most beautiful radial aggregates ('stellate aggre-es' of Sir John Flett) occurring in any British rock. They have been referred s spherulites; but comparison with true spherulites in acid lavas shows many nts of difference and the term is not applicable. In spherulitic obsidian or hstone the component fibres, whether cristobalite or sanidine or both, eloped about isolated centres with the same speed of growth and stopped at same instant of time. The result is perfect, or nearly perfect, solid spheres. se tourmaline aggregates, on the other hand, are rarely spherical, and except

[1] A. Brammall and H. F. Harwood, Min. Mag., 1925, vol. 20, p. 319.

when in the 'tourmaline felt' described below, are not solid. The dispersed nat[illegible] of the individual needles is best shown in sections remote from a centre of grow[illegible] in which case a scattered constellation of small, euhedral, basal sections is s[illegible] embedded in an irregular quartz mosaic (fig. 6, top right-hand corner).

Although so minute, each crystal is a highly euhedral prism, displaying [illegible] polar symmetry by colour changes from almost black at the nuclear end, thro[illegible] brown and green to colourless at the distal end. The basal sections are perfec[illegible] hexagonal (not trigonal); they are strongly zoned with almost black cent[illegible] bordered by bluish-green. Concentric with the centres of many of the de[illegible] aggregates are uniform, brown rings, of an almost constant radius (fig. 7).

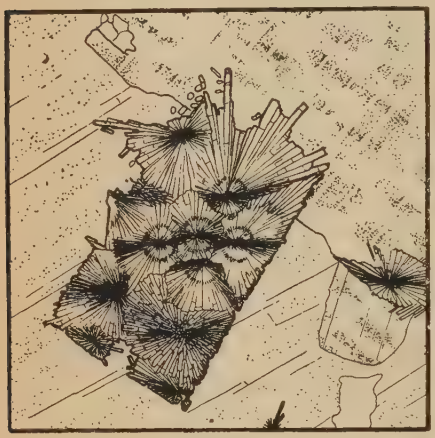

Fig. 7.

Fig. 8.

Fig. 7. Pseudomorph, probably after primary tourmaline, completely embedded in micr[illegible] perthite, and consisting solely of secondary sub-spherulitic tourmaline. ×20.

Fig. 8. Vertical sections of primary tourmaline prisms, zoned and surrounded by ou[illegible] growths of secondary, green tourmaline. Sections across two parallel disks of radial tourm[illegible] line-aggregate (bottom right). ×20.

somewhat a mystery why, at the same stage of growth, some thousands of growi[illegible] crystals should instantaneously change colour. This feature might have develop[illegible] after the growth of the crystals had ceased; but it is much more likely to be [illegible] effect of a slight alteration in the physical conditions during crystallization.

The stellate aggregates are most delicate indicators of the conditions obtaini[illegible] during their formation. Very few of them are symmetrical or even approximate[illegible] spherical, and the individual needles vary immensely in length in different dire[illegible] tions within one aggregate. There are four probable reasons for the wide sha[illegible] variations observed:

(1) Local differences in viscosity and irregular supply of material from whi[illegible] the growing prisms were drawing their substance, account for some of t[illegible] 'deformities'.

(2) In those examples varying from much-flattened spheroids to mere disk[illegible] dynamic stress was probably the controlling factor. It may be noted in th[illegible] connexion that several neighbouring aggregates often show a parallel maximu[illegible] elongation. Some part of the observed variation in shape is due to the differe[illegible]

entation of these bodies in the slides. An extreme case is that of a cross-section a disk-like form, which consists of a single line of crystals varying in azimuth m basal sections at the centre to prismatic ones at either end (fig. 8).

3) There remain many tourmaline aggregates which cannot be explained in se ways, however. Some of them appear to be conical in form, of fan-shaped tion therefore—such radial clusters have grown on the sides of early formed stals of felspar for example; but others are seen embedded in uniform quartz saic, and are less easy to explain. These are considered below.

Fig. 9.

Fig. 10.

IG. 9. Quartz mosaic containing haphazard acicular tourmalines marking positions of ital faces of earlier stage. Boundaries of quartz grains inserted to show the complete lack elationship between the former and the tourmaline: the V-shaped zone of inclusions tom centre) passes centrally through a large quartz grain. ×20.

IG. 10. The effect of mechanical shattering accompanied by injection of fluid silica carry- a little boron, &c. Note the very fine late outgrowths of tourmaline growing from margins uartz-filled channels and from xenoliths broken away from radial aggregates of tour- ine. Primary tourmaline (top left) surrounded by parallel fibrous form, and that by maline felt. ×20.

4) Another extraordinary feature of the aggregates is the frequent abrupt nination of the component prisms along straight lines, that surely represent -existing crystal faces (figs. 6 and 9). Between crossed nicols, however, these ight lines are entirely unrelated to the existing boundaries of the quartz ins in the mosaic. There are two possible explanations: either these ghost- ndaries represent crystal faces of minerals which have been pneumatolysed of existence (e.g., felspar replaced by quartz); or they mark the position of edral pre-tourmaline quartz crystals. The latter, being first in the field, set limits to the growth of the tourmaline. After the formation of this tourmaline, interstices were infilled with a secondary outgrowth, in optical continuity h the original quartz. Thus the once-euhedral faces were destroyed, though earlier structure is faithfully indicated by the tourmaline.

he relation between the primary, yellow tourmaline and the green pneu- olytic forms is of considerable interest. The significant facts are as follows:

1) The greatest concentration of stellate aggregates is invariably found round

much-corroded relics of primary tourmaline (figs. 8 and 5). The latter v evidently unstable under the new conditions and suffered corrosion.

(2) The corrosion embayments are now occupied by fibrous green tourma all the fibres being parallel and in optical alinement with the corroded nuc (fig. 10). Less frequently the parallel fibres are perpendicular to the *c*-axis o nucleus, though these may well be outgrowths from, rather than replacements the primary crystal (fig. 8).

(3) This parallel habit gives place outwards to a zone of dense, fibrous bru forming a solid felt of sub-spherulitic tourmaline (figs. 10, 5, and 4).

(4) Implanted on this felt are outwardly directed radial aggregates of n stouter prisms, penetrating freely into quartz mosaic.

The above sequence (1) to (4) is so clearly displayed about a number of corro yellow nuclei, some of which are reduced to mere shapeless shreds, that reasonable to envisage the further step involving the complete elimination o primary by the secondary tourmaline. Much of the latter has originated in t manner. Pseudomorphs of rectangular shape, still perfect in form, though sisting solely of sub-spherulitic tourmaline occur, sometimes embedded in fels (fig. 7). They contain no trace of the original mineral, and the shape is diagnostic; but there is little doubt that these were prisms of primary tourmal completely altered at a stage when felspar had hardly been attacked.

As to the significance of the facts (1) to (4), the tourmaline of parallel fibr habit was still under the control of the original lattice, and the change was textu rather than compositional, though a slight atomic reshuffle was involved, absorption formula for ω changing from light buff (for the primary nucleus) deep bluish-green (for the secondary type). The felt of radial brushes is a exclusively tourmaline, but resulted from greater atomic mobility, and repres an attempt to develop an independent crystal habit. The coarser stellate agg gates growing freely into quartz mosaic developed under conditions of maxim atomic mobility, in 'channels' between 'islands' of disappearing felspar a primary tourmaline.

It may be noted that the felt sometimes contains considerable numbers short, stout, perfectly hexagonal, dark-cored prisms of a different order of mag tude altogether from the fibres building the aggregate in which they are embedd There is no doubt that these developed from the felt by recrystallization un the general urge of the pneumatolytic conditions: nothing more than a sli structural change is involved: but it gives yet another generation of tourmal crystals of distinctive habit.

The accessory minerals shed little light on the process of pneumatolysis. Apat occurs sporadically as large, often rather irregular prisms, sometimes corro and with fine solution channels parallel to the *c*-axis. These short prisms cont dusky cores, and in basal sections they may be almost black throughout (fig. top, left and right). Other smaller clear, doubly-terminated prisms eviden belong to a later generation, suggesting that the cored crystals are pre-pn matolytic.

Summary of the 'pneumatolytic' changes.

The above account refers to the mineralogical and textural chan developed in a very small portion of an Armorican granite placed in the pa

mineralizers rich in borofluoric flux, concentrated in and escaping from the nitic magma.

Of the original minerals, quartz, felspar, and tourmaline, the second and third ved unstable under these conditions. The felspar was attacked for the soda d alumina, essential for the growth of the new tourmaline; while the yellow rmaline, after a period of corrosion, served as nuclei about which radially dis- sed acicular tourmaline crystallized.

The question naturally arises as to the extent to which the rock was actually uefied during pneumatolysis. The new tourmaline has not crystallized freely and about the felspar, while the structure of the latter has been sometimes ained. This suggests that the conversion of the microperthite into quartz saic with a very little microlithic tourmaline was effected largely by molecular fusion. It was a two-way diffusion, silica and boron moving in across the spar boundaries, and alumina, potash, and soda moving out in the opposite ection. The main lines of attack by the pneumatolysing agents are shown by channels referred to above, within which delicately acicular crystals of tour- line, of relatively great length, developed freely in all directions: they were arly growing in a fluid environment, which later 'set' as quartz mosaic con- ning fluid and gaseous inclusions in abundance. But such local molecular fusion and liquefaction do not seem suitable vehicles for the large-scale transfer pneumatolytic material through any thickness of granite, and there is evidence another process, which may well be important. This is mechanical shattering d all the phenomena of stoping on an extensive, though microscopic, scale. e shattering has affected all the primary minerals, and allowed the invasion of iceous fluid under pressure to wedge off micro-xenoliths, forming anastomosing ins. The displaced sides of the channels so produced could sometimes be fitted gether again with jig-saw precision (fig. 10); but in many other instances the ins are ill-defined. Wholesale breaking up of some of the stellate aggregates s produced innumerable pieces, ranging from conical segments to short sections two or three contiguous prisms, scattered in all directions in the quartz mosaic. his was the third cause of irregularity in the shape of the tourmaline aggregates, erred to above.

The material which was intruded during this period of shattering was very gely silica, but with a small amount of potential tourmaline, which crystallized the form of short, very fine needles, growing in optical alinement into the annels from the torn ends of the larger tourmalines, or as a fine outgrowth from e fractured xenoliths of stellate aggregate. In addition, some of the channels e margined by a haphazard mesh of fine microlithic tourmalines, looking like anded flotsam. The quartz in the channels shows none of the normal vein- artz structure, but occurs as very long crystals—one crystal may completely a vein—and there is no observable difference between the quartz in the veins d that outside in the ordinary mosaic.

The fact that the largest tourmaline aggregates have been involved in this attering shows that the mechanism continued beyond the phase of maximum idity. The effects of arrested stoping are clearly shown at this late stage in the oling of the rock. Similar but earlier episodes of shattering will have had their ects obliterated by the greater fluidity and fluxing of that time. The process ay well be an important factor in this type of pneumatolysis.

The amount of replacement of the primary minerals in this rock has been gre indeed it has locally been so thorough that the evidence of change is circumstan only. To-day, when the igneous origin of many so-called igneous rocks is be called in question, and when so much is claimed for mineralizing agents in re genesis, it is useful to look again at an instance where the evidence of replacem is beyond question by reason of the many relics of its past history that rem decipherable.

Acknowledgements.

The writer is grateful to Professor W. T. Gordon for facilities afforded in t Department of Geology at King's College, London; and to Dr. A. K. Wells advice and guidance during this investigation.

Pyroxenes from the Lower Carboniferous basalts of the Old Pallas area, Co. Limerick.

By the late D. F. Ashby,[1] B.Sc., A.R.C.S., F.G.S.

[Communicated by F. G. H. Blyth; read January 24, 1946.]

author commenced his study of the Lower Carboniferous and interbedded volcanic rocks ie Old Pallas area in 1935. Four years later he published a short account of the geology of district.[2] Just before his death the author had almost completed his laboratory work on porphyritic pyroxenes in three of the basalts, and the paper now presented, which is ittedly incomplete, has been assembled from his notes. Mr. F. G. H. Blyth has most rously given of his time to determine with the universal stage the 2V and γ:c values, and hecked the manuscript. Acknowledgement is also made to the Royal Society for a grant eet the cost of chemical analyses.—W. F. Whittard.)

THE most complete succession of Carboniferous rocks found in Co. Limerick crops out in the Limerick basin, which is situated between Limerick and perary. The zonal ranges of the chief lithological divisions of the Lower boniferous rocks have been determined, and two volcanic episodes, represented he Lower and the Upper Volcanic Groups, are now known to have occurred y in S_1 and early in D_1 times. The porphyritic pyroxenes have been isolated n representatives of the lower group, which 'constitute a graded series of ine-basalts, trachybasalts, trachyandesites and trachytes, comparable with

Table I. Analyses of rocks. (Analyst, Geochemical Laboratories.)

	I.	II.	III.		I.	II.	III.
... ...	44·43	45·26	51·13	MnO	0·25	0·17	0·19
... ...	12·74	14·87	16·58	CO_2	1·28	2·58	0·56
... ...	7·41	3·34	4·14	S	—	0·06	0·04
... ...	5·34	8·38	6·22	Cr_2O_3... ...	—	0·012	0·012
... ...	6·43	4·51	2·73	V_2O_3	—	0·020	0·009
... ...	12·05	9·81	6·11	NiO	—	0·01	nil
... ...	2·85	2·70	4·24	CoO	—	0·004	nil
... ...	1·42	1·58	2·89	BaO	—	0·04	0·05
+105° C. ...	1·77	2·02	1·92	SrO	—	nil	nil
−105° C. ...	0·46	0·38	0·41		100·31	99·956	99·991
... ...	3·45	3·45	2·22	Less O for S...	—	0·03	0·02
... ...	0·43	0·76	0·54			99·926	99·971

Olivine-basalt, Dunsapie type, 4160 feet N. 20½° E. of Pallas Grean railway station from er Volcanic Group exposed in canal cutting.

Olivine-basalt, 1000 feet E. 10° N. of Brackyle school, Pallas Grean, Lower Volcanic p.

I, Olivine-trachybasalt, 300 feet W. 6° S. of summit of Derk Hill, Lower Volcanic Group.

Donald Frederick Ashby was accidentally drowned in Barmouth estuary on July 31, 1943, promising career was cut short at the age of 28. He was born at Parson's Green, London, ctober 10, 1914. In 1938 he was geologist on the University of London Arctic Expedition n Mayen Island, and the same year was appointed assistant lecturer in geology in the ersity of Bristol. He joined this Society in 1938. Obituary notices in Quart. Journ. Geol. London, 1945, vol. 100 (for 1944), p. lxi, and Proc. Geol. Assoc. London, 1944, vol. 55,

D. F. Ashby, The geological succession and petrology of the Lower Carboniferous volcanic of Co. Limerick. Proc. Geol. Assoc. London, 1939, vol. 50, pp. 324–330.

the Lower Carboniferous Scottish suite. Among the olivine-basalts, all Scottish types have been recognised, with the exception of Craiglockhart and mugearite. Macroporphyritic basalts akin to Dunsapie or Markle types conspicuous among the earlier flows, while among the later ones microporphyr types predominate, of which the Dalmeny type is the commonest' (loc. p. 327).

The porphyritic pyroxenes of two olivine-basalts and an olivine-trachyba were selected for investigation. The rocks were crushed, the sieved fracti treated with heavy liquids, and the denser constituents further separated ele magnetically into groups. The pyroxene concentrates were picked over und binocular microscope and samples of the pure mineral prepared for chem analysis; the parent rock was analysed in each case. The refractive indices w determined by the single variation method, using a monochromatic illumin of variable wave length and a refractometer (Tables I, II).

TABLE II. Analyses and optical data of pyroxenes. (Analyst, Geochemical Laborato

	I A.	II A.	III A.
SiO_2	50·23	45·86	48·77
Al_2O_3	5·29	8·30	4·18
Fe_2O_3	1·16	2·08	2·03
FeO	4·48	7·03	9·34
MgO	14·74	12·65	12·48
CaO	20·50	20·23	20·49
Na_2O	0·70	0·68	0·51
K_2O	0·10	0·11	0·02
$H_2O+105°$ C.	0·66	0·54	0·98
$H_2O-105°$ C.	0·03	0·02	
TiO_2	0·92	2·34	1·59
P_2O_5	0·05	0·05	nil
MnO	0·25	0·17	0·11
CO_2	0·68	0·20	—
	99·79	100·26	100·50
Weight per cent. Wo.	47·5	48·3	46·8
Weight per cent. En.	43·4	36·6	34·2
Weight per cent. Fe.	9·1	15·1	19·0
Refractive indices* α'	1·685	1·707	1·699
Refractive indices* β	1·690	1·714	1·706
Refractive indices* γ'	1·706	1·727	1·722
Refractive indices* $\gamma'-\alpha'$	0·021	0·020	0·023
2V (+) range	46–52°	46–49°	52–53°
2V (+) mean	49°	48°	52°
γ': c†	53°	55°	44°

* The author contemplated correcting his determination of α' by $-0{\cdot}004$ and of γ' $+0{\cdot}004$. The calculated value of 2V would then be much higher than the observed one t the uncorrected determinations for the refractive indices are therefore preferred.

† The extinction-angles here given were measured by Mr. Blyth on sections nearly para to (010). Further measurements were made by him with the universal stage, using Bur method, which gave an unsatisfactorily wide range of values for I A and II A, and in the c of III A a range of 38–49°; it appears probable that for pyroxene III A, γ:c lies betw 44° and 49°.—W. F. W.

After allowing in the pyroxenes for small amounts of such impurities as calci apatite, and chlorite (probably a ferruginous pennine) which are indicated by t

sence of CO_2, P_2O_5, and $H_2O+105°$ C., and which can be identified in thin es of the pyroxenes, the constitutions and formulae of the three types can be nputed as shown in Table III.

TABLE III. Calculation of the formulae of pyroxenes.

	I A.			II A.			III A.		
	Mol. ratios.	No. metal atoms when O=6.		Mol. ratios.	No. metal atoms when O=6.		Mol. ratios.	No. metal atoms when O=6.	
...	0·8060	1·913		0·7380	1·744		0·7694	1·880	
...	0·0448	0·213	0·087 } 2·00 0·126	0·0755	0·357	0·256 } 2·00 0·101	0·0315	0·154	0·120 } 2·00 0·034
...	0·0053	0·025		0·0111	0·052		0·0096	0·047	
...	0·0513	0·122		0·0888	0·210		0·1149	0·281	
...	0·3316	0·787		0·2852	0·674		0·2617	0·639	
....	0·3488	0·828	1·983	0·3564	0·842	2·012	0·3654	0·893	1·987
...	0·0113	0·054		0·0110	0·052		0·0080	0·039	
....	0·0011	0·005		0·0012	0·006		0·0002	0·001	
...	0·0115	0·027		0·0292	0·069		0·0199	0·049	
...	0·0040	0·009		0·0024	0·006		0·0016	0·004	

I A. ... ... $(Ca,Mg,Fe'',Mn,Al,Fe''',Na,K,Ti)_{1\cdot 983}[(Si,Al)_2O_6]$
II A. ... ... $(Ca,Mg,Fe'',Mn,Al,Fe''',Na,K,Ti)_{2\cdot 012}[(Si,Al)_2O_6]$
III A. ... ... $(Ca,Mg,Fe'',Mn,Al,Fe''',Na,K,Ti)_{1\cdot 987}[(Si,Al)_2O_6]$

e analyses accord with Barth's view that the early precipitated pyroxene of alts is enriched in lime and magnesia relative to iron,[1] and demonstrate the ull extent to which aluminium replaces silicon.

T. F. W. Barth, Crystallization of pyroxenes from basalts. Amer. Min., 1931, vol. 16, 195–208. [M.A. 5–219.]

Variation in the structure of zircon.

By Vaughan H. Stott, D.Sc.
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and Alfred Hilliard, M.Inst.F., F.G.S.
British Coal Utilisation Research Association.

[Read November 1, 1945.]

In the course of an investigation on refractory materials, in which the identifi tion of minerals by their X-ray diffraction patterns had a prominent pla an interesting observation was made on a zircon of gem quality which was le to us by the courtesy of Mr. B. W. Anderson.

It may be recalled that the existence of three allotropes has been postulated order to explain the considerable variations of physical properties which found when comparing different specimens of zircon. In particular, densit ranging from 3·95 to 4·86 have been observed, the density of zirconium silica calculated from X-ray measurements, being 4·71. The difference between 4· and 4·86 may be assumed to be due to the presence in solid solution of met heavier than zirconium, amongst which hafnium is usually present to an appre able extent. On the other hand, the discrepancy between 4·71 and 3·95 is t large to be due to the influence of impurities of low density. The work of Anders and Payne, of Chudoba, and of others,[1] has discredited the alternative hyp thesis of allotropes of zircon, and the view is generally accepted that natu zircon of low density contains decomposition products of the original miner Thus, whilst zircon having a density of about 4·7 may be expected to exhibit normal X-ray diffraction pattern, the characteristic spots or lines (according the method of obtaining the pattern) produced by zircon of low density a diffuse to an extent depending on the deviation from the standard density. T diffuse pattern, however, is still that of zirconium silicate, although in o instance Chudoba observed in addition a pattern corresponding with a cub form of zirconia, which is known to exist in the presence of a small quantity magnesia. The liberated silica appears to form a glassy phase.

It would appear that the lattice of zircon of low density contains a vast numb of imperfections which are equivalent to localized decomposition, the produ of which are very commonly amorphous in the case of material of gem quali The degradation of the lattice is associated with changes in optical properties, a zircon gems of very low density are usually green.

The specimen[2] lent to us by Mr. Anderson is a typical, almost clear green sto from Ceylon, and has the very low density of 3·965. For X-ray examination t pear-shaped specimen was mounted so that molybdenum radiation could passed through its tip, the specimen being rotated during exposure. Contrary expectations, the diffraction pattern, instead of being that of a single crystal, a sharp pattern of the 'powder' type showing no appreciable preferred orient tion, or in other words, the gem contains a large number of minute crystals wi

[1] Mineralogical Abstracts, **7**–130, 131, 522, 523; **8**–123, 377.
[2] B. W. Anderson and C. J. Payne, Gemmologist, London, 1939, vol. 9, p. 4. [M.A. **7**–522

heir axes arranged at random. The pattern (fig. 1) is that of monoclinic zirconia ig. 2), no trace of the silicate or of crystalline silica being evident. If we assume he gem to contain the theoretical proportions of zirconia and silica (67·23:32·77),

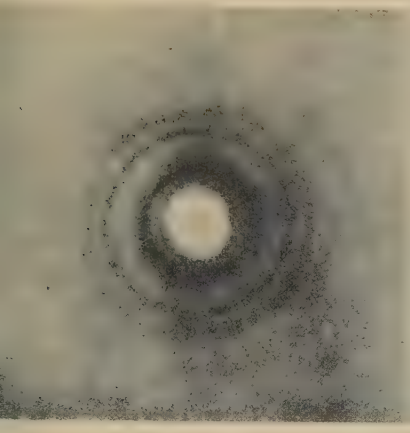

Fig. 1. Low-density gem zircon.

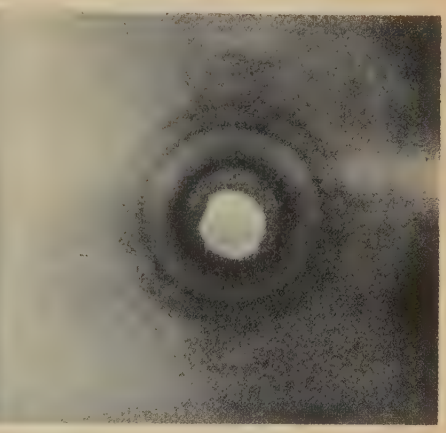

Fig. 2. Monoclinic zirconia.

d take the density of monoclinic zirconia to be 5·70, and that of amorphous ica to be 2·21, the calculated density of the mixture is 3·76. This is somewhat wer than the measured density of 3·965, but the difference may be reasonably cribed to the presence of fnium and other impurities, d perhaps partly to a slight cess of zirconia in the gem, r analyses of various stones ve shown such variation to possible.

That there is little or no pre-red orientation of the zirconia ystallites in the gem is indi-ted by the close approach to iformity of density in each cle appearing in fig. 1. In ct, each separate crystallite elds a pattern consisting of e or more groups of spots, ch group consisting of spots ling on one of a number of aginary circles through the nmon centre of which passes axis of the original X-ray beam. The combination of such patterns produced a large number of randomly oriented crystallites results in a number of rings almost uniform density.

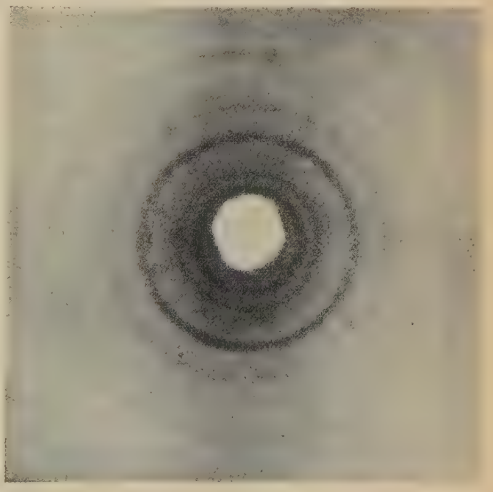

Fig. 3. Zirconium silicate (normal zircon).

Whilst it is easy to understand that decomposed zircon consisting of amorphous

material should be transparent, it is surprising to find that a material consistin of a large number of crystallites embedded in a glass of high silica content almost clear, for there is a large difference between the refractive indices of mon clinic zirconia and that of amorphous silica. The crystallites in the almost cle gem are presumably too small to scatter much light, and for this reason the linear dimensions cannot be much greater than 10^{-5} cm. The X-ray patter shows, however, that they cannot be much smaller than this, for if they were, th diffraction rings would be more diffuse. The range of possible size of the crysta lites is therefore fairly small. The value of 10^{-5} cm. is to be regarded merely a an estimate which roughly satisfies the conditions.

We have recently had occasion to carry out various heat-treatments on zirc of normal density and constitution, and on certain related materials. By me of X-ray analysis estimates have been made of the proportions of zirconiu silicate and zirconia in the crystalline part of the products. Zirconium silicat tetragonal, and in all our experiments the zirconia has been found to be mon clinic, whilst the silica was always present in a glassy state. Probably the presen of impurities and the comparatively rapid rate of cooling were hindrances t the crystallization of the silica. As thermal decomposition proceeds, the X-ra pattern due to zirconium silicate naturally becomes fainter, but in our experien these patterns remain sharp, unlike the pattern given by Chudoba's gems. O the other hand, the zirconia pattern, although it becomes stronger with increasin decomposition of the silicate, becomes at the same time more diffuse. Suc diffuseness suggests the presence of very fine particles or of lattice distortion, o of both. With regard to the first possibility, zirconia crystallites can be seen wit the microscope in specimens of zircon which have undergone considerable de composition, and these crystallites appear larger the further decomposition ha proceeded. They may, however, be accompanied by crystallites which are to small to see, and which may thus be responsible for the broadening of the line of the X-ray diffraction pattern.

Some of the results which may be relevant in connexion with any theor devised to explain the formation of a gem specimen such as described above a given in table I.

With regard to the additions shown in table I, the metals added to specime 14 to 25 and to specimens 28 and 29 are chemically equivalent to the potassiu contained in an addition of 2 % KF. In the case of specimens 30 and 31 th fluorine addition is equivalent to an addition of 2 % KF.

Considering specimens 1 to 6 it will be noticed that heating for an hour a 1,650° C. effects some decomposition. It is possible, however, that the amount decomposition occurring at a high temperature is greater than that found aft cooling, since recombination may occur if cooling be slow enough. The series specimens 7 to 10 shows that zircon which has decomposed to a considerab extent can be reconstituted by firing to Cone 20 (about 1,500° C.). Similarl experiments 32 and 33 show that zirconium silicate may be synthesized.

Heatings and coolings described as slow were carried out in a recuperative kil in which heating occupied about a week, and cooling about three days. Thos described as quick were carried out in a smaller furnace which was taken to th maximum temperature in a few hours, and cooled in about 24 hours. It seem unlikely that much recombination took place during the cooling of this furnac

specimens 16, 21, and 27 contained no zirconium silicate after firing. Specimen was heated in a recuperative kiln which was better lagged than that used for er slow firings. Unlike the cases just quoted, specimen 34 contained no ition. The estimated degree of decomposition is in line with the corresponding ues for specimens 1 to 6.

TABLE I. Heating experiments.

Specimen.	Addition to zircon wt. %.	Heating and cooling rate.	Firing schedule. (Cone 20, about 1,500° C.)	Estimated composition of crystalline part after cooling. $ZrSiO_4$ (tetragonal).	ZrO_2 (monoclinic).
Zircon compact	0	slow	Cone 20	100	0
No. 1 re-fired	0	slow	1,500° C. for 6 days	100	0
No. 1 re-fired	0	quick	1,600° C. for 1 hour	100	0
No. 1 re-fired	0	quick	1,650° C. for 1 hour	90	10
No. 2 re-fired	0	quick	1,700° C. for 1 hour	60	40
No. 1 re-fired	0	quick	1,750° C. for 1 hour	60	40
Zircon sand	0	—	Unfired	100	0
Zircon sand	0	quick	1,750° C. for 1 hour	30	70
No. 8 crushed, compacted, and re-fired	0	slow	Cone 20	100	0
No. 9 re-fired	0	quick	1,700° C. for 1 hour	50	50
Zircon gem from Ceylon	0	—	Unfired	100	0
Green zircon gem from Ceylon (fig. 1)	0	—	Unfired	0	100
Zircon sand	5% KF	quick	1,700° C. for 1 hour	5	95
Zircon compact	3% BaF_2	slow	Cone 20	70	30
No. 14 re-fired	ditto	slow	1,500° C. for 6 days	70	30
No. 15 re-fired	ditto	quick	1,700° C. for 1 hour	0	100
Zircon compact	1·1% MgF_2	slow	Cone 20	95	5
No. 17 re-fired	ditto	slow	1,500° C. for 6 days	95	5
Zircon compact	1·9% AlF_3	slow	Cone 20	100	0
No. 19 crushed, compacted, and re-fired,	ditto	slow	Cone 20	100	0
No. 20 re-fired	ditto	quick	1,700° C. for 1 hour	0	100
Zircon compact	1·3% Li_2CO_3	slow	1,500° C. for 6 days	100	0
No. 22 re-fired	ditto	quick	1,700° C. for 1 hour	60	40
Zircon compact	3·9% Pb_3O_4	slow	Twice to Cone 20	100	0
No. 24 re-fired	ditto	quick	1,700° C. for 1 hour	75	25
Zircon compact	3% China-clay	slow	Cone 20	100	0
No. 26 re-fired	ditto	quick	1,700° C. for 1 hour	0	100
Zircon compact	2·4% K_2CO_3 added as frit	slow	Cone 20	100	0
No. 28 re-fired	ditto	quick	1,700° C. for 1 hour	30	70
Zircon compact	2·5% $ZrOF_2$	slow	1,500° C. for 6 days	95	5
No. 30 re-fired	ditto	quick	1,700° C. for 1 hour	40	60
2·3 parts $ZrOF_2$ + 30 parts SiO_2 (pptd.)		slow	1,500° C. for 6 days	60	40
42 parts K_2ZrF_6 + 30 parts SiO_2 (pptd.)		slow	1,500° C. for 6 days	70	30
Zircon compact	0	specially slow	1,690° C.	70	30

rom consideration of the phase rule it would be expected that equilibrium ld be possible between zirconium silicate, zirconium oxide, and the amorphous se at a fixed temperature, or more exactly at a temperature varying to an nportant extent with ordinary variations of pressure. In the presence of urities, instead of an equilibrium temperature, a small range of temperatures ld be expected. The experiments quoted above, based on X-ray diffraction

data, indicate that the decomposition temperature of zirconium silicate prob lies between 1,500° and 1,650° C.

TABLE II. Chemical analyses of zircon sand from Travancore, before and after heating

	Natural zircon sand as received.	After firing to 1,700° C. for 1 hour.
SiO_2	29·41	31·62
ZrO_2+HfO_2	61·82	63·01
TiO_2	2·33	2·24
Al_2O_3+rare-earths+P_2O_5	5·61	2·60
Fe_2O_3	0·45	0·48
Mn_3O_4	0·27	0·11
MgO	0·10	nil
CaO	nil	nil
Na_2O	0·12	0·36
	100·11	100·42

At an early stage of the present work, there was some reason to suspect t the addition of a small quantity of potassium fluoride to zircon, followed b suitable heat-treatment, might result in vigorous crystal growth. Figs. 4 a

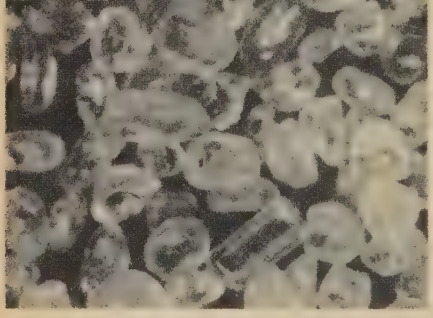

FIG. 4. Natural zircon sand. ×60.

FIG. 5. Recrystallized zircon. ×60.

show respectively raw zircon sand, and a compact of the same with addit of 4 % of potassium fluoride. The compact was maintained for 4 hours in a furnace at a temperature between 1,500° and 1,550° C. The well-developed crys with sharp edges shown in fig. 5 is typical of many others, and has probably be formed by growth from the original material. The average difference in si however, between the new and the old crystals is small, and owing to difficult of sampling a sure choice cannot be made between the alternative hypotheses crystal growth and of slow etching of the sand grains by the glassy matrix. attempting to form a judgement, it must be remembered that fig. 5 shows pron nently the pyramid faces of zircon, but the greater part of the crystal is hidd by these faces.

It is hoped that the information obtained, especially the establishment of the decomposition temperature in the neighbourhood of 1,580° C., may prove of assistance to mineralogists.

Our thanks are due to the respective Directors of the National Physical Laboratory and the British Coal Utilisation Research Association for permission to publish this paper, and to Dr. W. A. Wood of the National Physical Laboratory for the X-ray examinations.

An X-ray Examination of decomposition products of chrysotile (asbestos) and serpentine.

By A. Hargreaves and W. H. Taylor.

Physics Department, College of Technology, Manchester.

[Read November 1, 1945.]

I. Introduction.

MANY of the experiments described in this paper were made in the course of an examination of problems arising in connexion with technical uses of fibrous asbestos, undertaken about three years ago at the request of Dr. W. Francis, at that time Director of Research for Messrs. Turner Brothers Asbestos Company Limited, Rochdale. We have recently been able to investigate in a little more detail certain points which seemed likely to be of fairly general interest and we now present our results in the hope that they may be of use to other researchers in this field. We are indebted to Dr. Francis and his colleagues for valuable discussions on questions arising in the course of the work, and to the Directors of Messrs. Turner Brothers for financial assistance in connexion with the earlier experiments, and for permission to publish this paper.

In this paper the term 'chrysotile' is used for fibrous material (asbestos), 'serpentine' is used for the massive rock within which the veins of fibrous chrysotile are found, and 'antigorite' refers to the platy mineral of similar chemical composition. We have examined chrysotiles and serpentines from three different localities, and also the products obtained from them by prolonged extraction with water, and by heating for periods of a few hours at temperatures around 600° C. For this purpose we have used X-ray fibre photographs and powder photographs. Some of these are reproduced, but in view of the faintness of much of the significant detail in the X-ray patterns, it is necessary to give, in the text, full descriptions of observations made on the original X-ray films.

Our data, though inadequate at present to provide definite guidance in attacking specific problems of asbestos structure, are likely to have some bearing on three aspects of this fascinating subject—the atomic structure of chrysotiles and serpentines, the structural classification of chrysotiles and serpentines from different sources, and the relation between a fibrous chrysotile and the rock serpentine in which it occurs. The following are the principal studies which have contributed, in recent years, to our understanding of these problems.

The first attempt to determine the atomic arrangement in fibrous chrysotile was published by Warren and Bragg (1930) in a paper showing that a structure based on Si_4O_{11} chains, but with some degree of randomness, might account for the peculiar physical properties, and for some features of the X-ray fibre photograph characteristic of the mineral. Gruner (1937) reported unsuccessful attempts to carry out a detailed analysis of the structure, and concluded that some fundamental modification of the structure of Warren and Bragg was required. More recently, Warren (1941, 1942) and Aruja (1943) independently have re-examined the problem and have advanced new suggestions as to the chrysotile structure; we are indebted to Professor Warren and to Dr. Aruja for detailed information

the progress of their own work, most generously provided for our benefit in vance of publication.

The structural classification of chrysotiles and serpentines initiated in a survey a very general nature) by Anderson and Clark (1929), was discussed in detail Caillère (1936), Selfridge (1936), and Gruner (1937). The products formed on ting chrysotiles and serpentines were examined by Haraldsen (1928) and ner (1939) and by Hey and Bannister (1941) and Aruja (1943). The importce of this structural classification in relation to physical (especially electrical) perties of chrysotile asbestos was discussed by Francis and Grayson (1941). shall refer to all these researches later in the present paper.

For accounts of various hypotheses as to the mode of formation of the relatively all amount of fibrous chrysotile in the massive serpentine rock, reference may made to comprehensive reviews by Lodochnikov (1936) and Cooke (1937).

Experiments on extraction, in water, of chrysotile and serpentine.

If fibrous chrysotile is treated with dilute acid the magnesia may be completely moved, and the hydrated silica remaining, though fibrous in form, has comtely lost the elasticity characteristic of the original chrysotile fibre and gives X-ray pattern of one or perhaps two diffuse broad bands indicating that the ucture is 'amorphous' or 'glassy' in type.

In researches carried out in the laboratories at Rochdale prior to our X-ray rk, Mr. J. Grayson (at that time Research Chemist with Messrs. Turner others) made a detailed chemical examination of the products obtained by longed extraction of chrysotile fibre in water, amplifying the scanty data viously available. Extraction in a Sohxlet for 100–150 hours resulted in the aration of a small amount of solid material, of weight approximately 1 % of t of the original fibre and containing 45 % (by weight) SiO_2, 25 % MgO, 4 % R_2O_3, the remainder water. Continued extraction resulted in further aration of solid, but in diminishing amount until after 1800 hours no further preciable separation occurred, the total amount of extract being approximately % (by weight) of the original fibre. We have examined extraction products tained from chrysotile fibre and the associated serpentine rock, using specimens m the Bell mines, Thetford, Canada, from the Shabani mine, Rhodesia, and m the New Amianthus mine, Transvaal—henceforward termed Canadian, odesian, Transvaal materials. It should be noted that specimens for X-ray mination contain, in addition to the solid material extracted from the chryso- or serpentine, small amounts of material extracted from the glass vessel and water-soluble impurities which may be associated with the fibre or rock; in rticular, the presence of sodium chloride and iron salts may be anticipated. view of the difficulty of applying purely chemical methods to this problem, l in anticipation of the results of our X-ray examination of these materials, it nost interesting to note that Mr. Grayson suggested in a private communication t the chemical evidence indicated that the extracts might prove to consist of epiolite, i.e. magnesium trisilicate, prepared as a commercial product by the shington Chemical Company, ideal formula $2MgO.3SiO_2.2H_2O$.

It is convenient to discuss in turn extracts from fibres, extracts from rocks, and condition of the fibres after prolonged extraction treatment.

FIGS. 1–8. X-ray powder photographs of materials examined in the experiments extraction, in water, of chrysotile and serpentine. 1, Chrysotile fibre (powder photograph chrysotiles from Canada, Rhodesia, and the Transvaal, are identical on visual examinati 2, Serpentine rock (Transvaal). 3, Serpentine rock (Rhodesian). 4, Extract from Rhodes fibre. 5, Extract from Transvaal fibre. 6, Extract from Canadian fibre. 7, Extract fr Transvaal rock. 8, Extract from Rhodesian rock.

FIG. 9. Synthetic α-sepiolite.

FIGS. 10–14. X-ray powder photographs of products obtained by heating chrysotile fi and serpentine rock; after 4 hours heating at 600° C. 10, Canadian chrysotile. 11, Rhodes chrysotile. 12, Rhodesian serpentine. 13, Transvaal chrysotile. 14, Transvaal serpentine.

FIG. 15. Natural forsterite (olivine).

(i) *Extracts from chrysotile fibres.*

The products obtained by extraction of Canadian, Rhodesian, and Transvaal hrysotile fibres (figs. 4–6) give X-ray powder photographs in which there appears pattern of four diffuse wide lines, common to all three photographs, together ith other lines and wide bands which differ for the three extracts.

The photograph of Rhodesian extract (fig. 4) contains, in addition to the ommon pattern of four diffuse lines, a set of six or perhaps seven fairly sharp ut very weak lines. We have not been able to identify the structure or structures esponsible for this sharp pattern, but consider it probable that it is due to an npurity, or impurities—perhaps iron salts—present in the original fibre.

The Transvaal extract (fig. 5) gives a prominent set of sharp lines due to sodium loride, and one sharp but extremely weak line different from all the weak sharp nes of the Rhodesian extract pattern, as well as the common pattern of diffuse nes. Again it seems reasonable to suppose that only the diffuse lines of the mmon pattern are characteristic of the extract, the other lines representing npurities.

Canadian extract (fig. 6) gives a pattern consisting of the four diffuse lines of ie Rhodesian and Transvaal patterns, together with three very weak and diffuse nes which, as we shall see below, may probably arise from the same structure hich gives the four lines common to all three extracts.[1]

A powder photograph of synthetic α-sepiolite (fig. 9) contains three diffuse ines' or bands, and probably a fourth, which coincide in position with the lines the diffuse pattern common to all three extracts. The relative intensities of ie 'lines' are also the same, so far as may be judged by visual examination, and ie separate 'lines' show identical intensity-variations across their widths, e.g. ie second line (from the low-angle end of the film) shows a sharp edge on the w-angle side with a gradual fall of intensity on the high-angle side. The powder tterns thus appear to confirm that the extracts consist largely of α-sepiolite, suggested by Mr. Grayson; this point is discussed at length in section IV.

Photographs of 'powdered' chrysotiles (fig. 1) (prepared for us at Rochdale by ctioning in a microtome) from Canada, Rhodesia, and the Transvaal, are entical on visual examination and show a pattern containing broad bands and arp lines: the broad bands correspond to the four bands common to the extracts d α-sepiolite, together with the three additional broad bands seen only in the nadian extract; the sharp lines in the chrysotile pattern are, of course, absent om the extract patterns. This correspondence between the extract pattern and

[1] It is perhaps worth while to remark that the photograph of the Canadian extract also ows the diffuse broad bands seen in a photograph of hydrated silica obtained by acid extrac- n of chrysotile fibre as described above (Section II, first paragraph). These bands cannot be n in photographs of the Rhodesian and Transvaal extracts, a fact which may possibly be nificant in view of a statement by Caillère (1936, table on p. 202) that after prolonged ter extraction Thetford chrysotile loses silica and magnesia in the molecular ratio SiO_2/MgO ·3, while for five other materials tested (*not*, as it happens, including specimens from odesia or the Transvaal) the ratio is $SiO_2/MgO \sim 0{\cdot}5$ under identical treatment. Too much portance should not be attached to this observation; first, because in our Rhodesian ract, the only one fully analysed, the molecular ratio SiO_2/MgO is $\sim 1{\cdot}2$; secondly, because are not completely satisfied that these wide bands, so diffuse as to be recognizable only h extreme difficulty, are really characteristic of the experimental samples under examina- n.

the diffuse reflections of the chrysotile pattern is clearly of great interest, but w
postpone discussion of its structural significance for the present. We may, how
ever, note that there are differences in detail in the intensity-distribution with
the bands: thus the second band from the low-angle end of an extract patter
(with characteristic fall of intensity across the band, as described above) is re
placed in the chrysotile pattern by a pair of lines with a band of general scatteri
stretching between—the first line corresponding in position with the sharp (lo
angle) edge of the extract band, the second lying approximately half-way acro
the apparent width of the extract band. We may also remark that in view of th
correspondence between the bands of chrysotile and the seven bands of Canadia
extract, it seems reasonable to assume that this pattern may be characteristic
the extracts, and that only four of the seven bands are seen in Rhodesian an
Transvaal extracts as a consequence of less perfect crystallinity in these materi

(ii) *Extracts from serpentine rocks.*

No specimen is available of the rock associated with the Canadian fibre, bu
we have examined the natural rock and the extraction product (obtained by th
same treatment as for the preparation of fibre extracts) for Rhodesian an
Transvaal materials.

The powder photographs of the natural rocks are similar one to the other, an
to those of 'powdered' chrysotile fibres, as was to be expected in view of the da
published by previous workers. Careful examination reveals the following feature
which appear to be significant. First, photographs of samples of rock (Transvaa
very close to a fibre band, and in the centre of the rocky mass, are identical
visual examination. Secondly, photographs of rock (Transvaal) (fig. 2) and
the associated fibre show small but definite differences in intensities of certa
lines, but we have confirmed that these are explicable on the assumption th
the 'powdered' chrysotile fibre fails to take up a completely random orientation
partial preferred orientation would be expected with fibrous material of this kin
And in the third place, the photograph of Rhodesian rock (fig. 3) is quite definite
different from the photographs of Transvaal rock and of chrysotile fibres,
showing fairly sharp lines in place of bands, and differences of relative intensit
These differences, if confirmed and systematized, might provide a basis for
structural classification similar to those of Caillère (1936), Selfridge (1936), an
Gruner (1937), to which reference has been made in the introduction to this pape
but we have not been able to pursue this line of inquiry.

The photograph of Transvaal rock extract (fig. 7) is very similar to that of th
Transvaal fibre extract (fig. 5), showing the α-sepiolite bands, the prominen
sharp lines due to sodium chloride and also a few weak lines and one of modera
intensity not seen in the patterns of Transvaal rock, fibre, or fibre extract, whi
we have been able to identify as probably due to products originating from th
Sohxlet used in the extraction process.

Rhodesian rock extract (fig. 8) gives a pattern identical with that of Rhodesia
fibre extract (fig. 4) so far as the broad (α-sepiolite) bands are concerned, but th
pattern of very weak, sharp, lines seen in the fibre extract and attributed
impurities is no longer visible, while another single sharp line presumably indi
cates the presence of a different impurity (unidentified) in the rock.

Thus, although the natural rocks give patterns which differ in detail, th

ısvaal and Rhodesian rock extracts are apparently identical with the fibre acts.

(iii) *Chrysotile fibres after prolonged extraction.*

he powder photograph is not sensitive to very small changes in a sample, as might be expected to take place during prolonged extraction with water, ss there is a dimensional change which may be revealed by displacement of -angle lines. As rock specimens must be examined by the powder method, as the patterns of the natural materials before treatment contain few sharp s, there is no hope of obtaining information on possible slight changes in stitution for the serpentine rocks.

or the chrysotiles fibre photographs may be used, but although this is a more itive method (*except* for small dimensional changes) nothing of interest can ound unless the most refined technique is applied. Thus fibre patterns taken filtered Cu$K\alpha$ radiation are identical, on visual inspection, for natural adian, Rhodesian, and Transvaal fibres, confirming the evidence of photo-hs of 'powdered' chrysotiles (see section (i) above), for the same fibres after action for periods of 100 hours, and for samples taken from different parts of ven fibre—although the ends of the fibre are darkened by the extraction ess.

ibre photographs obtained with monochromatized radiation were described Aruja (1943). He used chrysotile fibres from Quebec, Canada, and detected, ddition to the intense pattern of sharp spots and 'streaky' or 'tailed' reflec-s lying on the principal layer-lines, faint traces of reflections on subsidiary r-lines lying between these layer-lines, and in positions corresponding to some he most intense reflections of the chrysotile pattern, but for an oriented cture with axis [010] or [013] parallel to the length of the chrysotile fibre, ead of [001] for the main chrysotile pattern. Aruja estimated that approxi-ely 3 % of the chrysotile must be in one or other of the two possible (abnormal) ntations, to account for the observed intensities of reflection of the small ber of extra spots observed. It should be noted that according to this inter-ation, other relatively strong reflections of the chrysotile pattern, for the ormal orientation(s), are superposed on reflections for the normal orientation so are not directly observed.

ur own fibre photographs, with monochromatized radiation, show interesting rences according to the place of origin: Canadian and Transvaal fibres show extra reflections, with approximately the same intensities relative to the cipal reflections so far as can be estimated on visual inspection, but in desian fibre the extra spots, though probably present, are so feeble that their ction is a matter of extreme difficulty. So far as we are aware, this is the first ctural test to reveal any difference between fibres (in the natural state) from rent sources.

photograph of Canadian fibre after extraction has been carried on for 200 s cannot be distinguished from the photograph of the original fibre, but after onged extraction (approximately 1700 hours, when according to Mr. Grayson's rvations no further action may be expected) the extra spots have almost, erhaps completely, disappeared from the pattern, which is otherwise un-ged to visual inspection except for some falling-off in the perfection of the

fibre-orientation of the main pattern. We have not yet been able to make sim tests on the Transvaal fibre because of the excessive demands which they m on apparatus needed for other work. These results are discussed later.

III. Thermal decomposition of chrysotile and serpentine.

Before describing our own experiments it is convenient to review, as briefl possible, published data on the products obtained by heating chrysotile serpentine.

Haraldsen (1928) applied X-ray methods to identify the products of the r decomposition of a serpentine from Snarum, Modum, Norway, selected fo purity, and of greenish-yellow colour. On heating, most of the water was d off between 500° and 700° C. X-ray powder photographs showed that the ch tile pattern, unchanged after heating at 500° C., disappeared completely a heating at 600° C., to be replaced by a single broad diffuse line at glancing-an 41° (for Fe$K\alpha$ radiation), but that after heating at 700° C. the olivine (forster pattern began to appear and increased in sharpness and detail after heating temperatures up to 1000° C.; at still higher temperatures, up to 1300° C., se of the most prominent lines of the enstatite pattern also appeared. Chem tests confirmed these observations on the high-temperature formation of enstat

Caillère (1936) used X-ray powder photographs along with chemical, opti and thermal methods, in establishing her classification of serpentine mineral fibrous chrysotiles, platy antigorites, and serpentine rocks—into two grou which she called α and β. On heating materials of group α, dehydration beg at approximately 550° C. and is completed at approximately 720° C., and an en thermic effect around 650° C. is followed by an exothermic change between 7 and 825° C., the latter accompanied by incandescence interpreted as indicat a recrystallization process. The X-ray powder pattern gradually becomes l distinct during dehydration, and has disappeared completely when dehydrat is complete; a new pattern appears on heating to approximately 850° C. (i.e. at the completion of the exothermic change) which indicates the formation of w crystallized olivine and enstatite. In contrast with this behaviour, materials group β show only the endothermic change at 650° C. (small exothermic chan observed at higher temperatures in some cases are not comparable with th observed in α materials, nor is there any incandescence), and the appearance the X-ray powder pattern also changes in quite a different way: for now as chrysotile pattern begins to fade at approximately 620° C. (as dehydration p ceeds) the olivine and enstatite patterns begin to appear—there is in this case gap between the disappearance of one and the appearance of the other. Caill showed that massive rock (serpentine) and included fibre (chrysotile) alw belong to the same group, α or β. She was unable to detect any differences betw X-ray powder photographs of specimens of chrysotiles of the two groups, a only very minor differences in a photograph of a massive rock of group β; rock of group α was examined. Of all the materials examined, only two asbes form varieties were found to belong to group α, one from the Amianthus mi Barberton, Transvaal, the other from Nerchinsk, Siberia, and of other α materi one was antigorite from Snarum (specimen no. 69.207),[1] facts of great interest

[1] We have not been able to decide, with certainty, whether all Caillère's material fr

ation to the work of Haraldsen (1928), reviewed above, and our own observa-
ns. The much more numerous β group was found to include many asbestiform
rieties, including specimens from Shabani in Rhodesia and Thetford in Quebec,
ich may well be expected to correspond to our Rhodesian and Canadian
terials.

Selfridge (1936) and independently Gruner (1937) examined by optical and
ray methods large numbers of minerals of this family, and established the
stence of two main structural types named 'chrysotiles' and 'antigorites'
ich give characteristic X-ray powder photographs. A supplementary note by
uner (1939) pointed out that this classification does not conform with Caillère's
ither an 'antigorite' or a 'chrysotile' may be either 'α' or 'β' type—and
orted (briefly) the results of heating materials of both types in air at tempera-
es around 600° C. Gruner found that a 'chrysotile' changes to olivine (and
bably colloidal silica) on heating at 560° C. for periods of 4 to 19 days, but
t an 'antigorite' changes more slowly unless the temperature is raised to 650° C.
found no trace of the enstatite pattern after treatment at either of these
nperatures.

Aruja (1943) found that after heating to 600°-620° C. the fibre-pattern charac-
istic of chrysotile (from Thetford, Quebec) begins to disappear, but simul-
neously a partially oriented olivine pattern appears, comprising sharp reflections,
bye arcs linking the reflections, and some general background. After heating
735° C. a further orientation in the olivine (forsterite) pattern takes place, the
bye arcs and general background tending to break up into sharp reflections.
er heating to 1000° C., a powder photograph shows the olivine pattern and
ery weak, broad, line corresponding in position with the strongest line of the
statite pattern. Optical examination and chemical analysis (Hey and Bannister,
41) suggested that silica is probably formed as the chrysotile breaks down to
vine. Aruja, and Hey and Bannister, discussed in detail the nature of the pre-
red orientation of the olivine formed.

In our experiments we have taken care to ensure that the recorded temperature
is nearly as possible that of the heated specimens, and for each temperature
cimens of all five materials have been treated at the same time in the same
ge-capacity furnace. The furnace was heated in approximately 3 hours to the
ected temperature, and was then maintained at that temperature for 4 hours
each case. After treatment, a portion of each specimen was used for powder
otographs, and a portion of each of the chrysotile samples for fibre photographs;
results of a careful examination of the X-ray patterns are summarized below;
iscussion of the significance of our data, especially in relation to earlier pub-
ed work, is given in the next section (IV).

(i) *Canadian chrysotile.*

After heating at 550° C., the fibre photograph (filtered Cu$K\alpha$ radiation) is
ntical with that of untreated material; after treatment at 600° C. (fig. 10) the

rum was of group α, for she refers to this locality in four places in the text: p. 218, 'pseudo-
phs of olivine from Snarum (no. 69.207)' are included in group α; p. 224, (pseudomor-
us) 'antigorite from Snarum' is included in group β; p. 234, 'antigorite from Snarum (no.
07)' is included in group α; p. 260, 'antigorite from Snarum' is quoted as an example of
It seems probable that the second reference (p. 224) is in error.

powder-pattern corresponds to a mixture of chrysotile and olivine (forsteri (fig. 15), and the fibre pattern confirms this; heating at 650° or 700° C. results complete disappearance of the chrysotile pattern, its place being taken by t forsterite pattern. In view of Aruja's discussion (1943) of the nature of t orientation of the forsterite crystals, we need only remark that our fibre patte are similar to his, though of course our experiments are confined to a sma temperature-range.

(ii) *Rhodesian chrysotile and serpentine.*

Rhodesian chrysotile behaves exactly as Canadian chrysotile, except that aft heating at 600° C. (fig. 11) it seems that a rather higher proportion of the Rhode chrysotile has been converted to forsterite.

Rhodesian serpentine (rock) is unchanged after heating at 550° C. for 4 ho It is, however, partly converted into forsterite at 600° C. (fig. 12); the lack sharpness in some of the high-angle lines of forsterite, and the relatively l intensity of this pattern, in comparison with the photograph of Rhodesian fi after identical heat-treatment, show that a much smaller proportion of the serpe tine has been converted into forsterite, and that the forsterite produced is l perfectly crystalline. In addition, one or two extra lines can be seen which have not been able to identify, and which probably correspond to some impur present in the rocky serpentine but absent from the associated fibrous chryso Treatment at 650° or 700° C. converts the serpentine completely into forster which is, however, less perfectly crystalline than that obtained from the chry tile; the same 'impurity' lines can also be seen.

(iii) *Transvaal chrysotile and serpentine.*

The behaviour of Transvaal chrysotile is similar to that of Canadian a Rhodesian chrysotiles, except that after treatment at 600° C. (fig. 13) the p portion of chrysotile converted into forsterite is smaller than for Canadian, a much smaller than for Rhodesian material. Too much importance should not attached to these quantitative differences, however, since it is possible that th may arise from differences in the state of subdivision of the specimens during t heating treatment.

After heating at 550° C. the Transvaal rock is unchanged, but after treatme at 600° C. (fig. 14) the serpentine pattern has almost disappeared—only three, possibly four, of the diffuse bands remain, and those are of very low intensity while there is no trace at all of the lines characteristic of forsterite. After heati at 650° C. the pattern of bands is again visible, unaltered, but in addition th are extremely faint traces of the three strongest lines of the forsterite patter so weak that they can be detected only with the greatest difficulty. Treatment 700° C. results in the disappearance of the band pattern, and the appearance the forsterite pattern though with relatively low intensity and some lack of p fection of crystalline development. Thus the stages in the thermal decompositi of Transvaal serpentine rock are quite different in detail from those for t Rhodesian serpentine, and the chrysotiles, examined in the course of this investig tion; in all three, the forsterite pattern is quite strongly developed before t chrysotile (serpentine) pattern disappears. These results are discussed below.

IV. Discussion of results.

Our experiments have not been confined to detailed examination of one sample
chrysotile, nor can they provide a comprehensive survey of chrysotiles and
rpentines from the large number of sources available; they do, however, open
p a number of interesting problems in connexion with structures of the 'asbestos'
ype, more particularly when they are considered in relation to previous investiga-
ons. We consider first the experiments on thermal decomposition of chrysotile
nd serpentine, and afterwards the products of water extraction of these materials.

A. *Thermal decomposition.*

We find no trace, in any of our powder photographs of heat-treated materials,
the sharp line pattern characteristic of enstatite. Our experiments thus con-
m the observations of Haraldsen (1928), Gruner (1939), and Aruja (1943) in
at low-temperature treatment does not result in the formation of enstatite; they
e not in agreement with Caillère's assertion (1936) that the pattern which
places that of chrysotile indicates the presence of crystalline enstatite as well
olivine. We have no new evidence on the possibility of high-temperature
rmation of enstatite, except that the powder photograph of Canadian chryso-
le, after (accidental) heating to a temperature probably considerably exceeding
50° C., shows an extremely faint wide band in a position corresponding to the
rongest line of the enstatite pattern; the presence of this band may indicate
e beginning of the formation of enstatite.

Our experiments give partial support to Caillère's classification into groups
and β. Thus our Canadian fibre, and Rhodesian fibre and rock, give X-ray
atterns (after heat-treatment) corresponding to group β, in that the new
orsterite) pattern appears strongly before the chrysotile (serpentine) pattern
as disappeared; this would be expected since Caillère found that specimens from
hetford in Quebec and Shabani in Rhodesia were of type β. Again, our Transvaal
rpentine (rock) behaves as would be expected for a material of type α, in agree-
ent with Caillère, whose classification is also supported by Haraldsen's examina-
on (1928) of Snarum material, α type. But chrysotile fibre from this same rock
found to correspond to type β, thus contradicting Caillère's assertions that
bestiform material from this locality proved to be of type α, and that rock and
sociated fibre are always of the same type, α or β.[1] As only two asbestiform
arieties, of the many examined, were found by Caillère to be of type α, and as
ir data are in disagreement with hers on one of these, we suggest that it is quite
ossible that all asbestiform varieties are actually type β.

No direct clue is provided by our heating experiments as to the fundamental
ructural significance of the α–β classification, which, indeed, clearly requires
investigation for a more representative selection of samples than have been
ailable for our work. We consider it very probable that some such classification

[1] In this connexion it is interesting to note that Caillère did not apply X-ray tests to the
bestiform varieties which she classified as α on the basis of thermal observations during de-
dration; that while our 'Transvaal' material is from the *New* Amianthus mine, hers is de-
ibed as from the Amianthus mine; and that since she found another sample of asbestiform
aterial from the same neighbourhood (Kaapsche Hoop, Barberton, Transvaal) to belong to
e β group, there is obviously some uncertainty as to the association of a definite type, α or β,
th this region.

of chrysotiles and serpentines can be established, but it seems unlikely that a one of the previous attempts (Caillère, 1936; Selfridge, 1936; Gruner, 1937) h taken all the relevant factors into account. Any such classification must obvio include the antigorite structure-type as described by Aruja (1943, 1945).

It is interesting to note that the pattern of three (or four) diffuse bands g by Transvaal serpentine (rock) after heat-treatment at 600° C., which presum represents the semi-crystalline portion of the products of thermal decompositi is identical with the patterns of synthetic α-sepiolite and of the chrysotile a serpentine water-extraction products, described in section II. This fact is co sidered below. It is also interesting to note that the most prominent of th bands corresponds in angular position with that reported by Haraldsen (1 for Snarum serpentine heated at 600° C.

B. *Water extraction.*

The experimental evidence summarized in section II suggests strongly t prolonged extraction of any of these materials, fibrous or rocky, results in t removal of small amounts of material, of semi-crystalline structure correspondi to the simple pattern of diffuse bands also characteristic of synthetic α-sepioli In the first place, therefore, the presence of this material in the original san does not, apparently, directly determine whether the material assumes the fibr form or not. On the other hand, it is interesting to find, in the case of the Canadi fibre examined with the necessary refinements of technique, that the 'extra spo (representing abnormally oriented material) disappear in the course of prolong extraction. This observation suggests that perhaps this part of the chrysot fibre is more readily removed than the major part with the normal orientatic we have not yet been able to test this by the preparation of monochroma photographs of Transvaal fibre after extraction, and by quantitative comparis of the total amounts of extract yielded by Canadian and Transvaal fibres on t one hand, and Rhodesian fibre (which shows no extra spots, or relatively ve weak ones) on the other.

Arising from these attempts to obtain information as to the nature of t extraction process, we have demonstrated that the presence of 'extra spo serves to differentiate our Canadian and Transvaal fibres from our Rhodesi fibre, and it is interesting to consider the possible significance of this differen tion. In the first place, whereas the examination of the process of therm decomposition (discussed in 'A' above) would suggest that all three fibres a similar (by contrast with Caillère's classification of Transvaal chrysotile as α, t others β), the examination of fibre patterns for 'extra spots' now indicates th Rhodesian fibre differs from Canadian and Transvaal, which are similar one the other; it seems clear that only a fuller examination of a number of differe materials can lead to the establishing of a reliable classification of structures this type. Secondly, it is possible that the electrical properties of asbestos (r sistance and break-down voltage) may be directly correlated with any classific tion of structure-types. Thus Francis and Grayson (1941) described experimen which demonstrate the superiority, in electrical properties, of Rhodesian fibre l comparison with Transvaal fibre, and also stated that Canadian (Quebec) fib would have poor electrical properties even if it were possible to remove complete

ıe magnetite which is intimately associated with the chrysotile.[1] They concluded ıat the observed superiority in the electrical properties of Rhodesian fibre, by ɔmparison with Transvaal (and Canadian) fibres, was another manifestation of ıe difference between β and α types of structure according to Caillère's classifica- ɔn. It seems, however, that Francis and Grayson were in error in thus making ıeir correlation include Canadian as α, even if Caillère's classification were ɛceptable, since only Transvaal and a particular Siberian fibre were found by ɛr to belong to the α group, Canadian fibre being of the β type. Further, our vn experiments (discussed in 'A' above) have shown that this actual Transvaal ɔre is of the Caillère β type, at least in respect of the process of thermal decom- ɔsition as shown by X-ray tests, so that the α–β differentiation does not serve to ·count for the difference in electrical properties. We have, however, found that hereas Rhodesian fibre gives no 'extra spots' (or extremely weak ones), both ·ansvaal and Canadian fibres show 'extra spots' which Aruja has interpreted arising from material with abnormal orientation, which we suggest may possibly · responsible for a modification of the electrical properties of the fibre: it would ɔviously be of interest to examine further this possible correlation of properties ith structure-type.

Finally, it is necessary to consider the significance of the diffraction-pattern ıaracteristic of the extraction products. This has been found to include four ffuse lines, or bands, for the fibre extracts (and in synthetic α-sepiolite), (with ree additional fainter bands for the Canadian extract), all of which correspond diffuse reflections in the pattern of the chrysotile fibre itself. We do not con- ler that these experimental data demonstrate that the α-sepiolite structure ists, as such, within the untreated chrysotile fibre, and that this component is nply removed by water extraction, although this would be the straightforward terpretation where the original complex powder-pattern of a mixture contains simpler pattern due to a 'soluble' constituent. In our case, however, the chryso- e pattern, containing some sharp lines and some diffuse lines, represents an ıperfect structure; and the extract pattern contains no sharp lines at all, but ly diffuse lines corresponding to some of those of the chrysotile pattern. From is we conclude that the extracts (and α-sepiolite) are imperfect structures, sed on the same pattern-units as the chrysotile structure, but showing even less ndency to perfect arrangement in a three-dimensional lattice. In view of the ɛent work of Warren (1941, 1942) and Aruja (1943) it is reasonable to suggest at the 'imperfection' consists in irregularity in stacking of the mica-like sheets, d in the placing of magnesium ions. Consideration of the variation in intensity ross the wide bands of the powder-pattern of the extracts gives rise to interesting eculations on the precise nature of these irregulatities—one 'line' is obviously the type associated with a two-dimensional lattice—but a more refined experi- ɛntal technique, and actual photometric measurements of intensity-variation, ɔ required as a basis for more detailed analysis. One suggestion may perhaps advanced, with due diffidence: the bands of the extract pattern correspond th the extremely faint 'extra spots' discovered by Aruja in the chrysotile

[1] From the wording of the paragraph in the original paper, it is clear that this assertion is ɛed, at least in part, on the authors' application and interpretation of Caillère's α–β classi- ıtion. It is perhaps useful to remark that the authors' structural interpretation of the ference between α and β types appears to be over-simplified.

fibre-pattern; it is therefore permissible to interpret the 'extra spots' as arising not from a small proportion of chrysotile fibre structure (complete as such, with the degree of perfection proper to chrysotile) in an abnormal orientation, but rather from the presence of a small proportion of the material with an imperfection in stacking of successive sheets (similar to that of the extract, and of synthetic α-sepiolite) greater than that which produces the characteristic chrysotile fibre pattern.

V. Conclusion.

It will be obvious that our experimental data require amplification if a serious theoretical study is to be made of some of the outstanding problems of the chrysotile-serpentine structures. We hope, however, that the investigations described will be of interest to others working in this field. We understand that Dr. A. Guinier has recently examined X-ray patterns of chrysotiles, but we have not yet obtained any detailed information as to the nature and aim of his researches.

We acknowledge our indebtedness to Dr. W. Francis and Mr. J. Grayson, who first introduced these problems to us, for invaluable information in frequent discussions, and for experimental material; to Professor B. E. Warren and Dr. E. Aruja for information on their own researches, in advance of publication; and to Mr. F. A. Bannister and Dr. M. H. Hey for private communications on their heating experiments. We wish to thank the Directors of Messrs. Turner Brothers Asbestos Company Limited, Rochdale, for financial assistance and for permission to publish this paper.

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MINERALOGICAL ABSTRACTS

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Notices of Books

NN (C. W.). *Chemical crystallography: an introduction to optical and X-ray methods.* Oxford (Clarendon Press), 1945, xii+422 pp., 234 figs. (some on 14 pls.). Price 25*s*.

he book is addressed to 'students of chemistry who wish to acquire some know-ge of crystallographic methods and research workers who wish to make practical of such methods'. It is divided into two sections, the first dealing with the identi-cion of solid substances by physical methods and the second with the determina-. of crystal-structures. After an introductory survey the author begins with apter entitled 'The shapes of crystals' and gives an introduction to crystal phology and to the relation between shape and structure. He approaches the ject of crystal symmetry through the phenomena of crystal growth and ieves a simplified treatment of elementary crystallography, e.g. indices of stal planes by means of the unit cell rather than in terms of axial ratios. s is followed by an account of crystal optics and the properties of crystals erved in the polarizing microscope, leading up to the procedure which is then en for the identification of transparent crystals by microscopic methods. The chapter of section one introduces the elementary theory of diffraction of ays and is concerned with the practical details of taking X-ray powder photo-phs for identification.

Over half the book is devoted mainly to the determination of the arrangements toms in crystals. This second section opens with an account of single-crystal niques, how unit-cell dimensions are determined and how this knowledge is plied to identification, the calculation of molecular weight, the determination composition in mixed crystal series, and to the deduction of the shapes of lecules and their orientation in the unit cell. The next chapter proceeds to determination of the space-group and the position of the atoms in the unit by the method of trial and error. Numerous examples of known crystal-uctures are worked out in detail ranging from simple ones like calcium oxide rutile to ascorbic acid ('vitamin C') and rubber hydrochloride. A chapter on tron density maps and vector maps includes an account of Fourier series hods, of the use of optical methods in place of calculations, and the scope of tor methods. The author also discusses the evidence on crystal-structure given optical, magnetic, and other physical properties, and concludes with a brief ount of broadened X-ray reflections and diffuse spots.

his book includes also topics of assistance to the research worker which have viously been published only as contributions to various scientific journals. instance, the use of oscillation photographs in the accurate setting of ill-ned crystals, the indexing of tilted crystal photographs suitable for crystals ing at least one short axis, and the location of atoms of nearly equal atomic nbers by using an X-ray wave-length lying between the absorption edges of atoms concerned.

ive useful appendices include a list of immersion liquids and a set of crystals efractive indices 1·326–1·97 for their standardization, and charts showing the

relation between plane-spacings and axial ratios, constructed for indexing with calculation the zero-layer lines of single-crystal rotation photographs and po photographs of substances other than orthorhombic, monoclinic, or anorthi

The text is profusely and clearly illustrated. An index to the volumi literature on X-ray crystallography is arranged under authors listed al betically and with references to the text. A detailed subject-index ends the b

F. A. B

Niggli (Paul). *Grundlagen der Stereochemie.* Basel (Verlag Birkhäuser), 19 283 pp., 207 figs. Price 32.50 Swiss francs.

The first of a series of chemical text-books dealing with the geometrical princ upon which stereochemistry is based. A knowledge of formal crystallogr including space-group theory is assumed, and the author's characteristic appr to the subject is developed in the first chapter entitled 'The symmetry rela of point arrangements'. Full use is made of the conventional diagramma representation of symmetry elements, but Schoenflies symbols are used throu out in preference to the simpler Hermann-Mauguin symbols now gener adopted. The second chapter discusses structural groups within point config tions, whilst the third gives a résumé of stereochemistry and figures many st tures mostly of well-known minerals. Bond types, resonance between ionic covalent linkages, ionic size, and the Pauling rules are topics briefly summariz but made subsidiary to the author's recondite studies. F. A. B

Rosický (Vojtěch) [1880–1942]. *Příručka pro určovací praktikum mineralogie* [Handbook for mineralogical determination exercises.] With a chapter chemical methods by Jaroslav Korta. Praha, 1939, 392 pp., 3 pls., text-figs.

Besides the usual methods based on external characters and chemical te much attention is given to optical properties, microchemical analysis, elect graphic (of A. Glazunov and R. Jirkovský) and colouring (S. J. Thugutt others) methods, and differential reactions, e.g. calcite-aragonite, pyrite-mar site, dolomite-magnesite, &c. The book is unique in its completeness of various methods of which the author has had many years of practical experie It was published after the German invasion of Czechoslovakia and the clos and pillage of the Czech universities. F. S

Raguin (E.). *Géologie des gîtes minéraux.* Paris (Masson et Cie), 1940, 613 138 figs.

This treatise is a worthy companion volume to the author's 'Géologie appliqu now in its second edition. The opening chapters deal with subterranean wat and thermal springs, geological maps, geophysical methods of survey, and application of the microscope to the study of ores. Ore-deposits classified in f main metallogenic types, according to the physico-chemical conditions un which they were formed, are discussed in general terms, the four types bei igneous, hydrothermal, aqueous infiltration, and sedimentary. Chapters giv detailed descriptions of the mineral deposits are conveniently arranged accordi to the use to which their products are put. There are chapters on precious ston combustibles (liquid and solid); fertilizers and salts; substances used in vari

lustries (clays, micas, fluorite and cryolite, baryte and witherite, bauxite, gnesite, talc, steatite, asbestos, and deposits of radioactive minerals and the e-earths, &c.); and, finally, the metallic ores. This last group occupies ten apters. The metals are taken in the order of the lithophil, siderophil, and alcophil elements of V. M. Goldschmidt [M.A. 2–159], beginning with tin, ngsten, and molybdenum and ending with silver, mercury, and gold. Under ch of the more important metals the different types of metallogenic deposits treated separately. An index of place-names and technical terms is a welcome dition, and the clear plan of the book and a full table of contents make for y reference. W. C. S.

MENT (Jack) & DAKE (H. C.). *Uranium and atomic power.* Brooklyn, N.Y. (Chemical Publishing Co.), 1945, x+343 pp., 16 figs. Price $4.00.

This book was first published in 1941 but was withdrawn from circulation early 1942 under censorship regulations. A foreword and a short appendix on the mic bomb has been added. It is concerned chiefly with the physics and mistry of uranium, and much information on these subjects has been brought ether. A chapter on uranium minerals gives a brief account of pitchblende l carnotite and lists other uranium minerals with a few words of description each. Parsonite is a misprint for parsonsite, and schroeckeringite for schroekerite. Prospecting for uranium minerals is dealt with very briefly. Tests for l methods of determination of uranium are fully described. W. C. S.

LWYN (A.). *The retail jeweller's handbook and merchandise manual for sales personnel.* London (Heywood & Co.), 1945, 417 pp. (480 pp. including paged advertisements), 13 col. pls., 303 text-figs. Price 17*s.* 6*d.*

This book is intended for master jewellers and their staffs, but it will have equal appeal to their customers and to all who are interested in jewellery l gemstones from any point of view. It is full of useful information. Chapters gold, silver, and platinum contain some accounts of the occurrence of the ores l mining methods. Here and there, in an attempt to present scientific theory non-technical language, the author gives a false impression, but such passages few. Diamonds and coloured gems are described with details of methods and les of cutting, grading, testing, and some account of mining. 'Improved' and ficial gems and synthetic stones are briefly treated, as well as pearls, cultured rls, and imitations. There is a very useful list of the gemstones with notes on our and correct trade-names approved for trade usage by the Jewellery Associan, together with indexes of correct and incorrect trade-names. The figures ude photographs of beautiful examples of the jeweller's art. The coloured tes are reproductions of postcards issued by the British Museum (Natural tory). W. C. S.

X-rays and Crystal-structure

NSDALE (Kathleen). *Experimental study of X-ray scattering in relation to crystal dynamics.* Reports on Progress in Physics, Physical Soc., 1943, vol. 9 (for 1942–43), pp. 256–293, 4 pls., 9 text-figs.

review of the experimental work on diffuse scattering and a discussion of how

Laval's work and that of Jauncey and his colleagues agrees with the Fax Waller theory. A useful bibliography is given. [M.A. 8–123, 129, 134, 282.]

F. A. B

Kochendörfer (Albert). *Über die Streuung der Interferenzpunkte und die ka Begrenzung der letzten Linien auf Röntgenaufnahmen grobkristalliner Werks* Zeits. Krist., 1943, vol. 105, pp. 10–22, 2 figs.

F. Regler (1942) has attributed the broadening of X-ray lines observed photographs of cast metals and alloys to refraction of the X-rays in passing fr air or vacuum into the metal. A mathematical treatment by the author re this explanation.

F. A. B

Laval (J.). *Diffusion des rayons X par les cristaux. (Étude théorique appl à la sylvine.)* Bull. Soc. Franç. Min., 1941, vol. 64, pp. 1–138, 37 figs.

A theoretical study of the diffusion effects produced by thermal agitation crystal-structure. A calculation of the intensity of diffusion is given in tern the instantaneous position of the vibrating atoms and a formula derived calculating the frequency and velocity of the elastic waves from the powe diffusion. The formulae are applied to the experimental data already obtai by the author for sylvine.

F. A. B

Laval (Jean). *Diffusion cristalline des rayons X par l'agitation thermique atomes.* Journ. Physique et Radium, 1943, sér. 8, vol. 4, pp. 1–12, 14 fig

Diffuse reflection effects due to thermal vibrations of the atoms can be simp represented in the reciprocal lattice by surfaces of isodiffusion. From the measu ment of the power of diffusion the velocities of the acoustic waves and t coefficients of elasticity can be calculated. [M.A. 7–232, 488; 8–129, 282.]

F. A. B

Olmer (Philippe). *Contribution à l'étude de la diffusion des rayons X en dehors réflexions sélectives de Bragg.* Mém. Faculté Sci. Univ. Paris, 1942, 20 p 7 figs.

A study of the diffuse reflections from sylvine and halite (at constant a variable temperatures) using monochromatized molybdenum X-rays.

F. A. B.

Ramachandran (G. N.). *A new derivation of the Darwin-Prins formula of X- reflection.* Proc. Indian Acad. Sci., Sect. A, 1944, vol. 20, pp. 100–106.

A new derivation of the Darwin (1914) and Prins (1930) formulae for reflection of X-rays by crystals which is claimed to be more rigorous.

F. A. B.

Straumanis (M.) & Ence (E.). *Die Konstruktion des räumlichen reziprok Gitters trikliner und rhomboedrischer Kristalle. Die Verwendung der Gitt* Zeits. Krist., 1943, vol. 105, pp. 1–9, 4 figs.

The method of construction of the reciprocal lattice previously describ [M.A. 8–283] is applied to the anorthic and rhombohedral systems. Providi rotation photographs with sufficient layer-lines about three axes are taken an

angles between these axes are known by goniometric measurement, the unit-dimensions can be deduced and the reciprocal lattice constructed.

F. A. B.

ITH (A. D.). *A method for calculating reciprocal spacings for X-ray reflexions from a monoclinic crystal.* Journ. Sci. Instruments, 1945, vol. 22, p. 74, 2 figs.

ne arm of an L-square is slotted parallel to its length and a hypotenuse scale nged to the slot and can move up and down. This device used in conjunction a monoclinic a^*c^* net permits the rapid evaluation of spacings for all values *hkl*).

F. A. B.

ITH (A. D.). *Accuracy of atomic co-ordinates derived from Fourier synthesis.* Nature, London, 1945, vol. 156, pp. 51–52.

aving calculated the structure factors from the final atomic co-ordinates, a rier synthesis is computed using these calculated values as coefficients. iations in the values of the co-ordinates thus derived give the errors, with rsed signs of the original co-ordinates. A trial with an actual crystal-structure ws them to have a value of $\pm 0{\cdot}02$ Å. These corrections can be applied to in more accurate values of atomic co-ordinates. A relation is deduced for ulating the most probable error in the co-ordinate, given the errors in the erimental determination of the structure factors and the effect of thermal ation.

F. A. B.

IRING (E.). *Über die Abkürzung der Belichtungszeit von Röntgenstrukturaufnahmen bei Anwendung von Reflexionsblenden.* Zeits. Techn. Physik. Leipzig, 1943, vol. 60, pp. 151–155, 1 pl., 3 text-figs.

otal reflection of X-rays by polished glass or metal surfaces permits the use mall-diameter (0·1 mm.) collimators 10 cm. long for sharp diffraction photo-hs in shorter exposure times. Examples of Laue photographs of rock-salt powder photographs of aluminium powder are reproduced. F. A. B.

NDRICKS (Sterling) & TELLER (Edward). *X-ray interference in partially ordered layer lattices.* Journ. Chem. Phys. (Amer. Inst. Physics), 1942, vol. 10, pp. 147–167, 3 figs.

he X-ray interference is calculated for layer lattices in which phase-shifts veen consecutive layers and the scattering powers of individual layers do not w a strictly periodic arrangement. After the consideration of special cases, general theory is applied to a specific partially ordered stacking of layers untered in mica and other minerals. F. A. B.

NIER (A.). *Détermination de la taille des particles submicroscopiques par les rayons X.* Journ. Chim. Physique, 1943, vol. 40, pp. 133–148, 2 pls., 8 text-figs.

he passage of X-rays through material made up of particles of colloidal ensions produces in addition to the Debye-Scherrer rings or haloes a diffrac-halo immediately in the vicinity of the incident beam. This halo yields rmation of the state of division of the material and gives a measure of the of grain. The breadth of the Debye-Scherrer or powder rings yields a measure

of the crystallographic grain-size. The observation of the central halo necessi strictly monochromatic X-rays, a special slit system, and photography in va Applications of the method to the determination of the sizes of large molecu albumin and high polymers and to the structure of heterogeneous alloy syst are described. F. A. B

Guinier (André). *La diffraction des rayons X aux très petits angles : applicati l'étude de phénomènes ultra-microscopiques.* Thèse, Faculté Sci. Univ. Pa 1939, pp. 1–82, 1 pl., 21 text-figs.

A quartz plate ½ mm. thick cut parallel to the (10$\bar{1}$1) face is hollowed ou the form of a cylinder 50 cm. radius and then bent to a cylindrical surface o cm. radius. The lattice planes (10$\bar{1}$1) are then lying on cylindrical surface 50 cm. radius and bring to a point focus a source of X-rays lying on a cylinde radius 25 cm. When used with a Seeman-Bohlin type of camera photographs w strictly monochromatic X-rays can be obtained in 1/50 time necessary with monochromators. This monochromator firmly attached to an X-ray tube is u to investigate diffraction effects at small angles and is particularly useful in study of colloidal solutions and carbon deposits. The third portion of the th is devoted to a study of the central smears obtained on X-ray photographs of age-hardened alloy of copper and aluminium. This effect is attributed to segregation of copper atoms in the (100) planes of the matrix. F. A. B

Laval (J.). *Sur un monochromateur pour rayons X. (Constitué par une la unicristalline courbée en forme cylindrique.)* Bull. Soc. Franç. Min., 19 vol. 66, pp. 371–388, 10 figs.

The conditions of selective reflection of a given wave-length from the conca surface of a curved crystal monochromator are calculated. The intensity X-ray reflection from (112) of calcite or (10$\bar{1}$1) of quartz is multiplied by fact of 234 and 246 respectively when appropriate curvatures of the crystal pla are employed. F. A. B

Aminoff (G.). *On new crystals to be used in chemical X-ray spectrography.* Arkiv Kemi, Min. Geol., 1945, vol. 18B, no. 14, 4 pp., 2 figs.

The lattice spacing of calcite is less when $p+q+r = 4i$ ($i = 1, 2, 3, \ldots$). surface ground in the position of (655) = (10$\bar{1}$4) has a spacing 1·032 Å., and gives a separation between Cu$K\alpha_1$ and Cu$K\alpha_2$ four times that from the cleav surface. [M.A. **9**–41.] L. J. S

Guinier (A.). *Mécanisme de la précipitation dans les cristaux d'alliages aluminiu argent pendant le durcissement structural.* Compt. Rend. Acad. Sci. Pa 1942, vol. 214, pp. 34–37.

A single crystal of a substance in which all the atoms are not arranged stric periodically diffracts X-rays outside the Bragg reflections. Each point in t reciprocal lattice then possesses a zone of diffusion. The observed effects are we and can only be observed with a stationary single crystal and strictly mon chromatic radiation. A study of the diffusion effects has been made of a sin crystal of a Cu-Al alloy containing 20 % silver, which up to 450° C. behaves as homogeneous phase δ. Rapid cooling after heating to 540° causes the precipitati

little islands of a γ-phase Ag_2Al, unlike the copper alloy where precipitation copper occurs along the cube planes. F. A. B.

INIER (André) & JACQUET (Pierre). *Sur le durcissement par revenu de l'alliage cuivre-glucinium.* Compt. Rend. Acad. Sci. Paris, 1943, vol. 217, pp. 22–24.

A micrographic and X-ray study of Cu-Be alloys of known hardness containing to 1·9 and 2·3 % of beryllium. After heating at 190° for 14 hours the X-ray otographs show smears revealing diffusion zones along the [100] axes of the iprocal lattice. Striations parallel to the intersections of the planes (110) ear on specimens which have been etched and polished after heating in uo. At higher temperatures a cubic γ-phase appears (unit-cell edge 2·70 Å.). interpretation of the phenomena observed in the transition α to γ is given. F. A. B.

LLNER (E.) & LAVES (F.). *Die Kristallstrukturen von $SrMg_2$, $BaMg_2$ und $CaLi_2$.* Zeits. Krist., 1943, vol. 105, pp. 134–143.

he unit-cell dimensions of $SrMg_2$ are a 6·426, c 10·473 Å.; of $BaMg_2$ a 6·636, ·655 Å.; and of $CaLi_2$ a 6·248, c 10·23 Å. All three alloys possess the $MgZn_2$ e of crystal-structure. A discussion of the differences observed between the arent atomic radii deduced from these structures and those usually accepted iven in some detail. F. A. B.

FFIELD (E. W.). *Mercurian silver from British Columbia.* Univ. Toronto Studies, Geol. Ser., 1945, no. 49, p. 71.

nugget (8 mm.) from a gold placer near Germansen landing, Omenico district, e sp. gr. 10·37, 10·39, a 4·10 Å. Analysis by V. B. Meen gave Ag 80·2 % and litative presence of Hg. M. A. P.

COCK (M. A.). *On potarite.* Univ. Toronto Studies, Geol. Ser., 1945, no. 49, pp. 71–73.

typical specimen from the Potaro river region, British Guiana, gave spectro- hic Pd, Hg, Au, and by analysis Pd 33·7 %, Au trace. The polished section ure white, homogeneous, and isotropic, with hardness C+. The cubic cell n a 5·21 Å. contains 4PdHg for which an atomic arrangement is suggested n space-group $T^4 = P2_13$. PdHg could not be made by fusion in vacuo or amalgamation. [Min. Mag. **21**–397; M.A. **4**–383.] M. A. P.

MSDELL (Lewis S.). *The crystal structure of α-SiC, type IV.* Amer. Min., 1944, vol. 29, pp. 431–442, 5 figs.

– *The crystal structure of α-SiC, type VI.* Ibid., 1945, vol. 30, pp. 519–525, 3 figs.

tructures are worked out in detail for the new types IV and VI of α-SiC A. **9**–96], and the atomic positions are listed for both the hexagonal and nbohedral unit cells. L. J. S.

ANOV (H.) & MINERVINA (Z.). *X-ray investigations of carborundum.* Acta Physicochimica, Acad. Sci. U.R.S.S., 1945, vol. 20, pp. 386–394.

lose-packed layers of interpenetrating tetrahedra CSi_4 and SiC_4 are stacked in

parallel or reversed orientation, the number and orientation of the layers giv the different types of carborundum. In the most frequently occurring ty SiC II the layers are 3-3; in SiC V, with c 128·3 Å. and 51 layers, 2-3-3-3 . . .; cubic SiC all layers have the same orientation. A review is given of the litera [except N. W. Thibault, M.A. **9**–96] with tabulation of data. [M.A. **1**–318; **2**– **3**–18, 177; **4**–460; **5**–465; **6**–89.] L. J. S.

Kerr (Paul F.), Holmes (Ralph J.), & Knox (Margaret S.). *Lattice consta of the pyrite group.* Amer. Min., 1945, vol. 30, pp. 498–504, 3 figs.

Precision measurements with a back-reflection, symmetrically focusing X-r camera gave for pyrite from Leadville, Colorado, a 5·40667 Å.; cattierite, Co from Shinkolobwe mine, Katanga, a 5·52346 Å.; vaesite, NiS_2, from Kasc mine, Katanga, a 5·66787 Å. [M.A. **3**–339, **8**–285, **9**–188; Min. Mag. **25**–609] L. J. S.

Byström (Anders). *Monoclinic magnetic pyrites.* Arkiv Kemi, Min. Geol., 19 vol. 19B, no. 8, 8 pp.

X-ray examination of 20 samples of pyrrhotine from various localities Sweden showed only 5 to be hexagonal (a 3·434–3·437, c 5·714–5·726 Å.), wh 8 were monoclinic (a 5·933–5·941, b 3·425–3·430, c 5·677–5·689 Å., β 89·56–89·64 others being mixtures of the two types. There is no relation between the sy metry and the content of sulphur. The monoclinic form is transformed into t hexagonal at 500° C. L. J. S.

Oftedal (Ivar). *Unit cell and space group of chalcocite, Cu_2S.* Norsk Ge Tidsskrift, 1945, vol. 24, pp. 114–115.

Oscillation X-ray photographs of chalcosine from Cornwall gave a unit c a 11·8, b 27·0, c 13·4 Å., containing $96Cu_2S$, calculated density 5·97, space-gro probably $V_h^{19} = Cmmm$. A pseudo-cell $\frac{1}{3}a$, $\frac{1}{4}b$, $\frac{1}{2}c$ shows some relation to cu Cu_2S. [M.A. **3**–339, **5**–174.] L. J. S.

Hiller (Johannes E.). *Die Gitterkonstanten von Crookesit, Argyrodit und Co fieldit.* Zentralblatt Min. Geol., Abt. A, 1940, pp. 138–142.

X-ray powder photographs of crookesite from Skrikerum, Sweden, show it be cubic with a 14·69 Å., the unit cell containing six molecules $Cu_{15}Tl_2Ag_1S$ Argyrodite from Himmelsfürst mine, Freiberg, Saxony, is orthorhombic wi a 14·93, b 12·22, c 6·81 Å., containing $4(Ag_8GeS_6)$. Canfieldite (Ag_8SnS_6) fr Colquechaca, Bolivia, gives the same results, and is isomorphous with argyrod The suggestion is that these minerals are each dimorphous with a high-temperat cubic modification (similar to Ag_2S), but a preliminary heat-treatment was n successful in effecting the transformation. L. J. S.

Tunell (George). *The gold-silver tellurides.* Physical Rev. (Amer. Phys. So 1943, vol. 64, p. 313. (Abstract.)

Sylvanite ($AuAgTe_4$) and calaverite are monoclinic and krennerite is orth rhombic. The formula for the last two is $(Au,Ag)Te_2$; analyses show Au:Ag 3·5 4·07 in krennerite and 6·6–54·2 in calaverite. Each has a different space-gro but they are structurally similar, with each Au or Ag surrounded by 6Te on

:ted octahedron. In sylvanite and calaverite each Te is surrounded by 3Au g and 3Te. In krennerite each Te is surrounded by 3Au or 3Ag and 3Te, 1Au or 1Ag and 5Te, or by 5Au or 5Ag and 1Te. [M.A. 7–81, 82.]

L. J. S.

'IELD (E. W.). *Studies of mineral sulpho-salts: IX. Lengenbachite.* Trans. Roy. Soc. Canada, 1944, ser. 3, vol. 38, sect. 4, pp. 59–64, 1 pl.

nonoclinic pseudo-cell with a' 34·82, b' 5·745, c' 18·36 Å., β 85° 41′ contains $Ag_7Cu_5As_{24}S_{78} = 6[6PbS.(Ag,Cu)_2S.2As_2S_3]$. A smaller pseudo-cell has $a'' =$ and the true cell has $b = 2b'$. The crystals, with $a':b':c' = 6{\cdot}0610:1:3{\cdot}1958$, 41′ (X-ray), are elongated with [010] and flattened on (001), the perfect ıge; forms (100), (001), (101), (201), (301), (401); twin planes (100), ($\bar{6}$01). y powder data are given.

M. A. P.

'IELD (E. W.) & PEACOCK (M. A.). *Studies of mineral sulpho-salts: VIII—Plagionite and semseyite.* Univ. Toronto Studies, Geol. Ser., 1945, no. 49, pp. 17–39, 9 figs.

ıgionite crystals (sp. gr. 5·54) from Wolfsberg, Harz, give a unit cell with -group $C_{2h}^6 = C2/c$ (or $C_s^4 = Cc$), a 13·45, b 11·81, c 19·94 Å., β 72° 49′, con- ıg $Pb_{20}Sb_{32}S_{68} = 4[5PbS.4Sb_2S_3]$. Crystals of semseyite (sp. gr. 6·03) from ánya, Romania, give a unit cell with space-group $C_{2h}^6 = C2/c$ (or $C_s^4 = Cc$), 61, b 11·99, c 24·52 Å., β 74° 11′, containing $Pb_{36}Sb_{32}S_{84} = 4[9PbS.4Sb_2S_3]$. hed section and X-ray powder data are given for both species and for onite an angle-table for 38 forms on the accurate structural axial ratios.

M. A. P.

ANOV (G. S.)] Жданов (Г. С.) ZHDANOV (H. S.). *The crystalline structure of $Zn(CN)_2$.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1941, vol. 31, pp. 352–356, 1 fig.

om the X-ray data of Hanawalt, Rinn, and Frevel [M.A. **6**–227] a new ture is suggested.

L. J. S.

ANOV (G. S.) & SHUGAM (E. A.). *The crystal structure of $Hg(CN)_2$.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1944, vol. 45, pp. 295–296, 2 figs.

om the X-ray data of Hassel [M.A. **3**–246] and Hanawalt, Rinn, and Frevel . **6**–227] a new structure is suggested.

L. J. S.

SSEUR (H.). *Étude roentgenographique de la laurionite PbOHCl.* Bull. Soc. Roy. Sci. Liége, 1940, vol. 9, pp. 166–169, 2 figs.

ldsztaub's unit-cell dimensions and space-group determination are confirmed aurionite [M.A. **7**–84, 389]. A Patterson-Harker synthesis also confirms the ions of the lead and the chlorine atoms in the crystal-structure. Different ions have, however, been assigned to the positions of the hydroxyl groups ing a structure with greater symmetry and cohesion in which the lead atoms nine atoms, 5Cl and 4OH, as nearest neighbours.

F. A. B.

SSEUR (H.) & TOUSSAINT (J.). *Structure cristalline de l'atacamite.* Bull. Soc. Roy. Sci. Liége, 1942, vol. 11, pp. 555–566, 4 figs.

evious determinations of the unit-cell dimensions and space-group are

confirmed [M.A. **7**–389]. The atomic positions in the crystal-structure have deduced from Patterson-Harker syntheses. Interrupted chains of octa $CuCl_2(OH)_4$ and $CuCl(OH)_5$ are arranged parallel to the *c*-axis, probably expla how this is the vibration-direction of light rays with highest refractive inde the structure also accounts for the perfect cleavage parallel to (010).

F. A.

Byström (Anders). *The structure of weberite, Na_2MgAlF_7.* Arkiv Kemi Geol., 1944, vol. 18B, no. 10, 7 pp., 2 figs.

C. Brosset (Diss. Stockholm, 1942) found weberite [M.A. **7**–225] to be rhombic with *a* 7·05, *b* 7·29, *c* 9·97 Å., and he suggested a relation to c [M.A. **7**–232]. With a possible space-group $C_{2v}^{20} = Imm$ the structure resemb to pyrochlore and $Cd_2Sb_2O_7$ are now suggested. L. J.

Jensen (Aksel Tovborg). *Nogle simple salthydraters Krystalstruktur.* 5. No Kemikermøde, København, 1939, 1940, pp. 201–203, 3 figs.

—— *On the structure of $SrCl_2.6H_2O$.* Kgl. Danske Vidensk. Selskab, Math. Medd., 1940, vol. 17, no. 9, 27 pp., 11 figs.

X-ray oscillation photographs gave for $CaCl_2.6H_2O$ *a* 7·860, *c* about 3·87 for $SrCl_2.6H_2O$ *a* 7·940, *c* 4·108 Å.; and for $SrBr_2.6H_2O$ *a* 8·205, *c* 4·145 space-group $D_3^2 = C321$. The crystals are hexagonal prisms sometimes rhombohedral terminations, and they are not piezoelectric. Successive Fo approximations show columns of alternating $Sr(H_2O)_3$ and $3H_2O$, with eac surrounded by nine oxygens, three of them in a plane and not touching other Sr, and the others in two tetrahedral arrangements. Each Cl is surroun by six oxygens on a flat distorted octahedron. [M.A. **5**–24.] L. J.

König (Hans). *Eine kubische Eismodifikation.* Zeits. Krist., 1944, vol. pp. 279–286, 2 figs.

Water vapour condensed on a collodion film cooled with liquid air gave at ab —100° C. an electron diffraction pattern which is cubic with *a* 6·36 Å. and ei molecules in the unit cell. The structure is that of β-cristobalite, while ordin ice has the β-tridymite structure. 'Cristobalite-ice' is gradually transformed 'tridymite-ice' at about —80° to —70° C. without any appreciable chang density. [M.A. **8**–259.] L. J.

Brill (R.), Hermann (C.), & Peters (Cl.). *Röntgenographische Fouriersynth von Quarz.* Ann. Physik, 1942, ser. 5, vol. 41, pp. 233–244, 4 figs.

The electron density given by a Fourier analysis of quartz on $(11\bar{2}0)$ when jected on a plane nearly perpendicular to the join Si–O does not fall to ze suggesting that the lattice is not ionic, but probably with an intermediate ho polar and heteropolar bonding. The parameters agree with those of P. H. [M.A. **6**–329]. L. J.

Bond (W. L.) & Armstrong (E. J.). *The use of X-rays for determining the orien tion of quartz crystals.* Bell System Technical Journ. New York, 1943, vol. pp. 293–337, 30 figs.

The measurements of error of cutting of large numbers of quartz plates

ıally carried out by an X-ray goniometer using an ionization chamber to ɔt the reflected beam. If the error of cutting of a plate is large, if the cut is ·e one, or the orientation of the plate completely unknown, a back-reflection ɔ method is employed. A detailed description of this method is given.

F. A. B.

JCI (Laura) & OTT (Emil). *The structure of silica gel (X-ray study).* Journ. Phys. Chem. (Amer. Chem. Soc.), 1931, vol. 35 (2), pp. 2061–2064, 4 figs.

ica gel heated to 1150° C. for five hours yields an X-ray photograph showing it has been entirely changed into cristobalite. Photographs of freshly pre-ı gels not heated above 100° C. also show the presence of cristobalite crystals lloidal dimensions.

F. A. B.

INEK (M. H.) & FANKUCHEN (I.). *X-ray diffraction examination of gamma ılumina.* Indust. Engin. Chem. (Indust. edit.), 1945, vol. 37, pp. 158–163, 3 figs.

Alumina, prepared by dehydrating Al hydroxides (except diaspore), is much as a drying agent and dehydration catalyser. By a heat-treatment up to C. (at higher temperatures it is converted into α-Al_2O_3, corundum) the al particles are increased in size, and then show with high- and low-angle y scattering more lines in the pattern, from which a cubic unit cell a 8·4 Å. luced.

L. J. S.

ISER (Oskar). *Über eine neue Modifikation des Mangandioxyds.* Ber. Deutsch. Chem. Gesell., 1939, vol. 72, Abt. B, pp. 1879–1881.

ree different methods of preparing manganese dioxide are described which nearly amorphous powders deficient in oxygen ($MnO_{1·76}$–$MnO_{1·93}$). After ng the preparations with nitric acid the composition becomes $MnO_{1·97}$, and .er photographs now reveal the presence of a new form of manganese dioxide O_2. The author also gives a reference to earlier work by Dubois (1936) in ı another form (α-MnO_2) distinct from pyrolusite (β-MnO_2) is described.

F. A. B.

URDIE (Howard F.). *Microscopic and diffraction studies on dry cells and their aw materials.* Trans. Electrochem. Soc. New York, 1945, vol. 86 (for 1944), ɔp. 313–326, 15 figs.

ray powder data are given for two poorly crystallized modifications of anese dioxide, γ- and δ-MnO_2. These two modifications are most commonly l in artificial preparations and may be poorly crystallized pyrolusite and omelane, respectively. Natural MnO_2 ores used in the manufacture of dry nclude samples from the Gold Coast, ramsdellite and γ-MnO_2 (fine fraction); ana, cryptomelane and clay; Panama, pyrolusite; Philippines, cryptomelane morphous; Caucasus and Brazil, pyrolusite. The fine fractions of these ores identified with electron diffraction photographs. Electron microscope photo-s of the various manganese oxides, which are figured, show that they differ y in particle size and shape. Ageing and discharge products of dry cells in prismatic crystals of $Zn(NH_3)_2Cl_2$, hexagonal plates of $ZnCl_2.4Zn(OH)_2$, $nO.Mn_2O_3$ (hetaerolite) reduced from MnO_2.

F. A. B.

Byström (Anders). *X-ray studies on lead sesquioxide, Pb_2O_3.* Arkiv Kemi, M Geol., 1944, vol. 18A, no. 23, 8 pp., 1 fig.

Large black crystals of Pb_2O_3 were prepared by heating PbO_2 with Na solution in a bomb for 8 days at 250° C. They are monoclinic with *a* 7·4 *b* 5·616, *c* 3·365 Å., β 80·1°; possible space-groups are C_{2h}^2 or C_2^2. Lead ions ar two sets, probably tetravalent and bivalent. Formed with Pb_3O_4 were s black needles of $Na_2Pb_5O_{10}$; these are orthorhombic with *a* 11·8, *b* 9·8, *c* 3·1 [M.A. **8**–216.] L. J. S

Byström (Anders). *The decomposition products of lead peroxide and oxia products of lead oxide.* Arkiv Kemi, Min. Geol., 1945, vol. 20A, no 31 pp., 3 figs.

PbO_2 containing a little water (O 1·988, H_2O 0·030 mol.) is tetragonal *a* 4·942, *c* 3·378 Å. At 400–650° C. it decomposes, giving successively: α-P probable limits Pb_3O_5 to Pb_2O_3, monoclinic, *a* 7·72, *b* 10·82, *c* 11·48 Å., β 88·6 β-PbO_x, probably orthorhombic, *a* 3·89, *b* 5·49, *c* 3·82 Å.; PbO, tetrago *a* 3·964, *c* 5·009 Å.; PbO, orthorhombic, *a* 5·476, *b* 4·743, *c* 5·876 Å. Tetra PbO on oxidation at 350° C. passes to β-PbO_x and Pb_3O_4. [M.A. **5**–104; **8** 137, 216, 255, 256; **9**–43, 98.] L. J. S

Hägg (Gunnar) & Magnéli (Arne). *X-ray studies on molybdenum and tung oxides.* Arkiv Kemi, Min. Geol., 1945, vol. 19A, no. 2, 14 pp.

MoO_3 (α-phase) is orthorhombic with *a* 3·958, *b* 13·82, *c* 3·689 Å. and f molecules in the unit cell; space-group $D_{2h}^{16} = Pbnm$ [M.A. **5**–25, 178]. W heated with metallic Mo this gives blue-violet needles close to the composit $MoO_{2.90}$ (Mo_9O_{26}) of two phases β and β'; β' is monoclinic with *a* 16·84, *b* 4 *c* 14·52 Å., β 84°. A γ-phase close to $MoO_{2.75}$ (Mo_4O_{11}) is stable up to 700° C. δ-phase, MoO_2, is monoclinic with *a* 5·610, *b* 4·843, *c* 5·526, β 60·38°. The β'- γ-phases when heated at 350° C. give an ϵ-phase. WO_3 (α-phase) is triclinic [M.A. **5**–25]. A β-phase close to $WO_{2.90}$ as blue needles is monoclinic with *c* *c* 27·5, *b* 3·80 Å. A γ-phase close to $WO_{2.75}$ is monoclinic with *a* 18·3, *b* 3 *c* 14·0 Å., β 65°. The δ-phase, WO_2, is monoclinic with *a* 5·560, *b* 4·884, *c* 5·5 β 61·07°; space-group $C_2^2 = P2_1$. L. J. S

MacGillavry (C. H.) & Panthaleon van Eck (C. L.). *The crystal structur sodium and ammonium iodate.* Rec. Trav. Chim. Pays-Bas, 1943, vol. pp. 729–735, 7 figs.

$NaIO_3$, previously described as an antiperovskite [M.A. **4**–30], is orthorhom with *a* 5·74, *b* 6·37, *c* 8·11 Å., the unit cell containing four molecules; space-gr $D_{2h}^{16} = Pbnm$, with a co-ordination structure of Na and pyramidal-shaped ions in deformed CsCl packing. NH_4IO_3, previously described as a perovs structure [M.A. **3**–326], is similar with *a* 6·41, *b* 6·38, *c* 9·25 Å. L. J. S

Byström (Anders). *The structure of quenselite, $PbMnO_2OH$.* Arkiv Kemi, M Geol., 1945, vol. 19A, no. 35, 9 pp., 1 fig.

Quenselite from Långban [M.A. **3**–110] gave a unit cell *a* 9·118, *b* 5·676, *c* 5·604 ($a:b:c$ = 1·606:1:0·987, *a* and *c* being interchanged from Flink's setting) c

ning four molecules; space-group $C_2^1 = P2$. Sheets Mn–O–Pb–OH–Pb–O–Mn– parallel to the perfect cleavage (100). L. J. S.

ESSING (Leiv), LARSSON (Tollef), & MAJOR (Harald). *Isomorphous substitute for $Al^{'''}$ in the compound Al_2BeO_4.* Norsk Geol. Tidsskrift, 1943, vol. 22 (for 1942), pp. 92–99.

Heating mixtures of the hydroxides with $BeCO_3$ up to 1180° C. gave the follow- compounds with the chrysoberyl structure. With larger amounts of Ge a ıpound, probably Ge_2BeO_4 which can take up 25–30 % Al, has a different ıcture.

	a.	*b*.	*c*.	*a*:*b*:*c*.
Chrysoberyl	4·92	9·39	5·47 Å.	0·4707:1:0·5825
$AlGeBeO_4$	4·48	9·59	5·56	0·4672:1:0·5798
$AlFeBeO_4$	4·49	9·68	5·61	0·4637:1:0·5795
$AlCrBeO_4$	4·51	9·73	5·62	0·4635:1:0·5776

L. J. S.

ÉN (Lars Gunnar) & PETTERSON (Rolf). *Die Kristallstruktur von $Pb_2Cl_2CO_3$ (Phosgenit) und $Pb_2Br_2CO_3$.* Naturwiss., 1944, vol. 32, p. 41, 1 fig.

structure with no CO_3 groups [M.A. **5**–469] is improbable. A two-dimensional of Pb and CO_3 ions with Cl (or Br) in the meshes is suggested; space- up D_{2d}^7. L. J. S.

'EDAL (Ivar). *On the crystal structure of phosgenite $Pb_2Cl_2CO_3$ and the synthetic compounds $Pb_2Cl_2CO_3$, $Pb_2Br_2CO_3$, and $Pb_2(Br,Cl)_2CO_3$.* Norsk Geol. Tids- skrift, 1945, vol. 24 (for 1944), pp. 79–88, 5 figs.

aue, powder, and oscillation X-ray photographs of phosgenite from Monte i, Sardinia, and of artificial crystals gave:

	a.	*c*.	*c*/*a*.	*d* (*calc*.).
Phosgenite	8·125	8·860 Å.	1·091	6·19
(Br,Cl)-phosgenite	8·299	9·038	1·089	—
Br-phosgenite...	8·347	9·082	1·088	6·62

he unit cell contains four molecules. A pseudo-cell has $c/2$. A structure with groups is built up on the space-group $D_{4h}^5 = P4/mbm$, but may be different ıe crystals are really piezoelectric. Phosgenite is uniaxial positive and Br- ;genite uniaxial negative, while the mixed crystals are optically biaxial. \. **5**–469.] L. J. S.

ODORESCO (*Mlle* Marie). *Sur les molybdates neutres et leur diagramme de Debye et Scherrer.* Compt. Rend. Acad. Sci. Paris, 1944, vol. 218, pp. 233–234.

-ray powder lines are listed for $Na_2MoO_4.2H_2O$ and K_2MoO_4. L. J. S.

RO (Carlo). *Sulle costanti reticolari della brochantite.* Periodico Min. Roma, 1941, vol. 12, pp. 419–432, 2 pls.

eissenberg X-ray photographs of untwinned crystals of brochantite from neb gave *a* 13·07, *b* 9·82, *c* 5·99 Å., agreeing with the results of C. Palache, show that the system is monoclinic, not orthorhombic. [M.A. 7–493.]

L. J. S.

Bellanca (Angelo). *Sulla struttura dell'aftitalite.* Periodico Min. Roma, 19
vol. 14, pp. 67–98, 1 pl., 9 text-figs.

Aphthitalite from Vesuvius gave sp. gr. 2·697, ω 1·4882, ϵ 1·499 (Na), a
unit cell a 5·643, c 7·279 (c/a 1·290) containing $2KNaSO_4$; space-group D^3_{3d}.
structure consists of chains of K–SO_4 groups with Na in channels parallel to
c-axis. [M.A. 3–527.] L. J. S

Byström (Anders). *X-ray analysis of $Ca_2Sb_2O_7$ and compounds of similar com
tion.* Arkiv Kemi, Min. Geol., 1945, vol. 18A, no. 21, 8 pp.

The following compounds were prepared by heating the metal carbonates w
Sb_2O_3, Nb_2O_5, or H_3TaO_4 at 900–1200° C. $Ca_2Sb_2O_7$ (a 7·28, b 7·44, c 10·18
$Sr_2Sb_2O_7$ (a 7·44, b 7·66, c 10·36 Å.), and $Cd_2Sb_2O_7$ (a 7·21, b 7·33, c 10·14 Å.
orthorhombic with the weberite structure, a two-dimensional framewor
B_2X_7 octahedra. $Pb_2Sb_2O_7$ (a 10·38 Å.), $Ca_2Ta_2O_7$ (a 10·35 Å.), Cd_2Nb_2
(a 10·35 Å.), and $Cd_2Ta_2O_7$ (a 10·36 Å.) are cubic with the pyrochlore struc
a three-dimensional framework of linked B_2X_6 octahedra. L. J. S

Rivoir (L.) & Abbad (M.). *La estructura del nitrato talioso rombico.* Anal.
Quím. Madrid, 1943, vol. 39, pp. 306–331, 10 figs.

The symmetry of thallous nitrate is bipyramidal (not sphenoidal). The u
cell, a 6·17, b 12·27, c 3·98 Å., contains $4TlNO_3$; space-group probably D^2_2.
L. J. S

Dallemagne (M.-J.) & Brasseur (H.). *La diffraction des rayons X par
substance minérale osseuse.* Bull. Soc. Roy. Sci. Liége, 1942, vol. 11, 19
2 pls.

The mineral content of bone is mostly a mixture of hydrated α-tricalci
phosphate ($3Ca_3(PO_4)_2.2H_2O$) and uncombined calcium carbonate. X-ray pho
graphs of these two constituents in the molecular proportions of three to one
to reveal the calcite pattern. When bone is calcined at 900° C. the result
pattern is slightly changed and then is exactly identical with that of apatite.
is confirmed that the differences between the powder patterns of α-tricalci
phosphate and apatite and between the various members of the apatite fam
are small. F. A. B

Brasseur (H.). *Contribution à la connaissance de la fourmariérite.* Bull. S
Roy. Sci. Liége, 1941, vol. 10, pp. 369–372.

X-ray measurements yield a 14·52, b 16·72, c 14·07 Å. for fourmarieri
Thence it is calculated that the more probable formula is $PbO.4UO_3.5H_2O$ w
higher water-content. [M.A. 2–343, 384, 521.] F. A. E

Niggli (Paul). *Stereochemie der Silikate.* Vierteljahrsschr. Naturfor. Ges
Zürich, 1943, vol. 88, pp. 3–32, 27 figs.

A lecture illustrated with photographs of structure models. L. J. S

O'Daniel (H.) & Tscheischwili (L.). *Modellsubstanzen zu Silikaten.* Naturwis
1943, vol. 31, pp. 209–210.

$NaBeF_3$ (a 15·22, b 7·16, c 6·92 Å., β 93–97°) and β-wollastonite (a 15·33, b 7·

0 Å., β 95° 24′) both contain twelve molecules in the unit cell with space-group and are isotypic. Li_2BeF_4, Na_2BeF_4, K_2BeF_4, and $(NH_4)_2BeF_4$ are isotypic h zircon Zr_2SiO_4; and $Na_2[LiBe_2F_7]$ with gehlenite $Ca_2[AlSiAlO_7]$. [M.A. 2; **8**–139, 287, 290, 369.] L. J. S.

ESSING (Leiv). *Contribution à l'étude des métasilicates.* Norsk Geol. Tidsskrift, 1941, vol. 20 (for 1940), pp. 265–267.

$NiCaSi_2O_6$, obtained by heating $SiO_2+NiO+CaCO_3$ at 1200° C., gave *a* 9·67, 88, *c* 5·25 Å., β 74° 10′, and a powder pattern very similar to that of diopside ($CaSi_2O_6$) from Piedmont. L. J. S.

DANIEL (H.) & TSCHEISCHWILI (L.). *Strukturuntersuchungen an Tephroit Mn_2SiO_4, Glaukochroit $(Mn,Ca)_2SiO_4$ und Willemit Zn_2SiO_4.* Zeits. Krist., 1944, vol. 105, pp. 273–278, 1 fig.

Tephroite and glaucochroite from Franklin Furnace, New Jersey, both show powder pattern similar to that of γ-Ca_2SiO_4 [M.A. **8**–290], with the same space-up D_{2h}^{16} and containing four molecules in the unit cell: tephroite has *a* 4·86, 0·62, *c* 6·22 Å., and glaucochroite (sp. gr. 3·487) *a* 4·91, *b* 11·12, *c* 6·49 Å. ucochroite is probably a mixed crystal $(Mn,Ca)_2SiO_4$, rather than a double $MnCaSiO_4$ [M.A. **5**–104]. Light green willemite associated with the glauco-ite has *a* 13·92, *c* 9·32 Å. L. J. S.

LIET (V.) [–1945]. *Onderzoek over het verband tusschen chrysocolla, katangiet, plancheiet, bisbeeiet, shattuckiet en dioptaas.* [Investigation on the connexion between chrysocolla, katangite. . . .] Verh. K. Vlaamsche Acad. Wetensch. Lett. Belgie, 1942, vol. 4, no. 1, pp. 1–59, 4 pls. (Flemish with French résumé, pp. 57–58.)

review is given of the literature (bibliography 97 entries) on these copper ates, collecting together the data and the various chemical formulae that e been proposed. New X-ray data show that of the three types of plancheite A. **5**–44] one is identical with shattuckite and a second with chrysocolla. angite is identical with chrysocolla. The name chrysocolla has been often lied to mixtures of several minerals (with opal, cristobalite, and quartz). inct species, with the more characteristic lines in X-ray powder photographs, dioptase $CuSiO_3.H_2O$, 2·60, 7·24, 1·354, 2·11; shattuckite $2CuSiO_3.H_2O$, , 3·30, 4·94, 3·49; plancheite $3CuSiO_3.H_2O$, 10·09, 3·34, 4·93, 3·05; chrysocolla $iO_3.2H_2O$, 1·491, 2·911, 8·32 Å. L. J. S.

OGLIO (Massimo). *Nuove ricerche sulla simmetria e struttura dell' artinite.* Periodico Min. Roma, 1942, vol. 13, pp. 1–14, 2 pls.

rtinite forms tufts of radiating fibres on serpentine at Monte Motta in Val enco. Goniometric measurements gave $a:b:c = 5{\cdot}30754:1:1{\cdot}97540$, β 80° 14′, the forms (100), (001), (027), (301), ($\bar{7}02$), and (801). The crystals are flattened 001) and elongated along the *b*-axis. Etching with HCl on faces in the [010] gives unsymmetrical figures, indicating the sphenoidal monoclinic class. ay measurements gave *a* 16·66, *b* 3·14, *c* 6·21 Å., β 80° 15′; space-group obably $C_2^3 = C2$. [M.A. **6**–474, **7**–392.] L. J. S.

Brindley (G. W.) & Robinson (Keith). *Structure of kaolinite.* Nature, Londo 1945, vol. 156, pp. 661–662, 1 fig.

Fifteen samples of kaolinite from different localities yield identical powd photographs which, owing to the high resolution of the 20-cm. diameter focusi camera employed, exhibit some lines additional to those previously recorded Gruner [M.A. **5**–187]. These additional lines can only be reconciled with anorthic unit cell of dimensions a 5·14, b 8·93, c 7·41 Å., α 91·8°, β 104·5°, γ The structure differs from that of Gruner's in being only pseudo-monoclinic containing only one Si–O, Al–OH sheet. The anorthic symmetry of the struct accounts for the weakness of many of the lines as compared with those fo dickite, a strictly monoclinic clay mineral. F. A. B.

Gruner (John W.). *The kaolinite structure of amesite,* $(OH)_8(Mg,Fe)_4Al_2(Si_2Al_2)$ *and additional notes on chlorites.* Amer. Min., 1944, vol. 29, pp. 422–430.

Amesite from Chester, Massachusetts [M.A. **1**–71, 214], gave a unit cell a 5·2 b 9·20, c' 7·015 Å., containing $(OH)_8(Mg,Fe)_4Al_2(Si_2Al_2)O_{10}$; sp. gr. 2·782 (ca 2·789). It has essentially a kaolinite structure with a few chlorite units int stratified. The chlorites examined by McMurchy [M.A. **6**–45] were re-examin and the results tabulated. L. J. S.

Brosset (Cyrill). *Formation of an addition compound of calcium silicate a sodium fluoride.* Nature, London, 1945, vol. 156, pp. 451–452.

Acicular crystals of Ca_2SiO_4NaF, obtained by fusing mixtures CaF_2+SiO_2 Na_2CO_3 or $CaO+SiO_2+NaF$, have a unit cell, a 20·6, b 21·1, c 7·55 Å., β 89 containing 28 of these molecules; probably space-group $C_{2h}^5 = P2/c$; density 2·9 L. J. S.

Antipov-Karataev (I. N.) & Sedletzky (I. D.). *Composition of colloid disperse minerals and the metathetic capacity of glauconites from Saratov.* Compt. Ren (Doklady) Acad. Sci. URSS, 1943, vol. 39, pp. 115–117.

Glauconite from Lyssaya Gora, prov. Saratov, gave mean of 5 analyses Si 50·43, TiO_2 trace, Al_2O_3 6·25, Fe_2O_3 20·84, FeO trace, MgO 2·82, CaO 1· Na_2O 2·13, K_2O 4·93, H_2O+ 5·49, H_2O- 4·88, P_2O_5 0·69, CO_2 trace = 100· X-ray powder data of this material and after saturation with H or Li ions identical and indicate the presence of glauconite 50, montmorillonite sericite 10 %. L. J. S.

Economic Minerals and Ore-deposits

Emmons (R. C.). *A mineralogist's obligation.* (Presidential address.) Amer. Mi 1945, vol. 30, pp. 87–96.

Discusses the political control of mineral supplies. L. J. S.

Specimens and samples. Their treatment and use. British Columbia Department Mines, Victoria, B.C., 1944, Bulletin no. 18, 27 pp., 19 pls., 3 text-figs.

Instructions for sampling, labelling, and packing of specimens and samples, a an account of the methods used for the examination and assay of the specimens the Department of Mines laboratory in Victoria. A clear account is given of t

thod of spectrographic analysis. This makes a useful companion to the pro-. ctor's guide [M.A. **9**–19]. W. C. S.

LSON (H. D. B.). *Geochemical studies of the epithermal deposits at Goldfield, Nevada.* Econ. Geol., 1944, vol. 39, pp. 37–55, 8 figs.

Spectrographic analyses of about 50 samples of vein material and wall-rock w that only Bi, Ag, Sn are quantitatively and presumably genetically related Au. M. A. P.

TSON (Kenneth De P.). *Colloform sulphide veins of Port au Port peninsula, Newfoundland.* Econ. Geol., 1943, vol. 38, pp. 621–647, 21 figs.

Narrow comb-veins composed of calcite, galena with trigonal axes normal to walls, colloform-banded and bladed blende and wurtzite, nodular marcasite luding an anomalous variety (X-rayed), and sparse pyrite were formed at temperature in Ordovician limestone. M. A. P.

TMAN (Henry M.). *Paragenesis of the ore of the Normetal mine, Abitibi County, Quebec.* Econ. Geol., 1943, vol. 38, pp. 313–322, 12 figs.

A study of hand-specimens and polished sections of ore from this mine in the th part of Desmeloizes township shows four waves of mineralization: abun- nt pyrite replacing the wall-rock; pyrrhotine; quartz, blende, chalcopyrite; rcasite, galena. M. A. P.

OTTER (F. M.). *The age of the ore deposits of the Lake District and of the Alston block.* Geol. Mag. Hertford, 1944, vol. 81, pp. 223–229.

The view is advanced and supported by evidence that the mineralization of the d-zinc metallogenetic province of the 'Alston block' and of the Lake District of Tertiary age. The vein-ores of the two areas, in E. and W. Cumberland, pectively, show striking similarities although the rocks and structures differ damentally. Fluorite is recorded in the upper part of the Brandlehowe vein Cat Bells in the Lake District. Galena was encountered in Carboniferous nestone in a bore-hole near Hensingham, Whitehaven. Chalcopyrite and pink yte have been recorded at the Eskett iron-mine, and chalcopyrite and pyrite at Crowgarth iron-mine, both in the Carboniferous Limestone of Cleator Moor. nce it is concluded that the mineralization in the Lake District, as in Alston, post-Lower Carboniferous. The two mineral fields occur within dome-like uctures due to post-Triassic and presumably Tertiary uplift. W. C. S.

DALKA (G. L.) Падалка (Г. Л.). О геологическом строении северо-восточной Якутии в связи с металлоносностью. *On the geological structure of the northeast Yakutia in connection with ore deposits.* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1939, no. 5, pp. 3–20, 1 pl. (map).

— Металлоносность северо-восточной Якутии.—*The ore deposits of north-eastern Yakutia.* Ibid., 1939, no. 6, pp. 41–60. (Russian with English summary.)

n the first paper the author gives an account of the geology of Verkhoyansk trict in north-eastern Siberia, and in the second paper he describes the

ore-deposits which are associated with the granitic rocks of Mesozoic and Terti age. Two types of veins are distinguished: sulphide-cassiterite and gold. I of minerals and their paragenetic relations are given. S. I. T

[Zvyagintzev (O. E.)] Звягинцев (О. Е.). Геохимия золота.—[*The geochem of gold.*] Изд. Акад. Наук СССР (Publ. Acad. Sci. USSR), Moscow–Le grad, 1941, 114 pp., 3 pls., 38 text-figs.

This semi-popular booklet gives an interesting account of the modes of oc rence, genesis, and geochemistry of gold. Besides discussing well-known works the solubility and precipitation of gold, the author mentions several new Russ works, including some of his own. According to him, in hydrothermal veins, g is most probably precipitated from alkaline solutions at low temperatures. without the catalytic effect of sulphide minerals. Geochemical processes of g concentration from magmatic solutions and in the sedimentary rocks (pla coal, &c.) are discussed in detail. The following approximate calculations o average contents of gold are made, taking the average content of gold in earth's crust (5×10^{-7} %) as unity: meteorites 10·0, sedimentary rocks hydrosphere 0·005, anthroposphere (recovered by man) 0·001. S. I. T

White (William H.). *The mechanism and environment of gold deposition in ve* Econ. Geol., 1943, vol. 38, pp. 512–532, 13 figs.

Ores from 27 gold deposits in Canada and the United States show gold minutely fractured and recrystallized quartz veins, and suggest that the me was deposited at a low temperature from a progressively concentrated primit hydrothermal fluid which permeated the fractured veins. M. A. P

Baker (M. B.). *Gold and iron prospects in Canada.* (Presidential address.) Tra Roy. Soc. Canada, 1943, ser. 3, vol. 37, sect. 4, pp. 1–8.

Most of the 60,000,000 oz. of gold which has been produced by Canada has be mined since 1900. Before 1900 gold came mainly from rich placers, and the sear for pre-Cambrian drainage patterns might reveal further rich deposits. Geophysi prospecting might discover iron-ores of the Lake Superior type. M. A. P

Armstrong (H. S.). *Gold ores of the Little Long Lac area, Ontario.* Econ. Ge 1943, vol. 38, pp. 204–252, 18 figs.

A description of specimens from seven mines in a pre-Cambrian area 75 mi north of Lake Superior, Port Arthur mining division, with eleven tables giv the inferred order of formation of the ore and gangue minerals in different o bodies, and a generalized sequence for the area. M. A. P.

Bruce (E. L.). *Gold-silver ratios in certain Ontario gold mines.* Trans. Roy. S Canada, 1943, ser. 3, vol. 37, sect. 4, pp. 23–31, 3 figs.

This ratio seems to decrease with depth. M. A. P.

Jensen (Einar). *Sølvet på Kongsberg. Om de kjemiske prosesser ved dets utfelli og om trådsølvdannelsen.* [Silver at Kongsberg. On the chemical processes its precipitation and on the formation of wire silver.] Norsk Geol. Ti skrift, 1939, vol. 19, pp. 1–106, 11 figs. (English summary, pp. 94–99.)

The silver ores (mainly native silver with some argentite) at Kongsberg oc

the veins where they are intersected by narrow cross-veins usually containing rhotine. Numerous experiments were made on the precipitation of silver m solutions in the presence of various sulphide minerals at 130° C. Arsenides, gnetite, and ilmenite can also act as precipitants. Alternative views on the thod of deposition of the ores are discussed. Wire silver is formed when Ag_2S eated in a solution of Ag_2SO_4 containing Cu and Sb. [M.A. **9**–144.]

L. J. S.

UMANN (Henrich). *Native copper and silver ore deposits in Dalane, Norway.* Norsk Geol. Tidsskrift, 1944, vol. 23 (for 1943), pp. 214–219, 4 figs.

lakes and threads of native copper and native silver are disseminated in rtzite, with felspar and sericite, near its junction with greenstone (metamor- sed basic lava which presumably yielded the metals). No sulphides are ent, but some of the copper has a thin rim of cuprite. Several small mines e been worked intermittently since early times. L. J. S.

GNÉE (I. de). *Origine du disthène associé au minerai de cuivre de Luishia (Katanga).* Ann. Soc. Géol. Belgique, 1941, vol. 64 (for 1940–41), Bull. pp. B 272–B 283, 2 figs.

he occurrence of kyanite embedded in massive chalcopyrite, described by Buttgenbach in 1925, appears to contradict the view of the mesothermal gin of the Katanga copper deposits. It is now shown that the kyanite is the ier mineral and is also present in the schists of the country-rock. Later copper- ring solutions partly altered the kyanite to muscovite and sericite.

L. J. S.

RENKO (A. A.) Петренко (А. А.). Геология Еленовского медно-турмалинового месторождения и признаки медного оруденения в северных Мугоджарах (в. склон ю. Урала).—*The geology of the Elenovskoye copper-tourmaline deposit, northern part of the Mugodjar mountains, eastern slope of the south Urals.* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1943, no. 1, pp. 87–104. (Russian with English summary.)

ccording to the author the mineralization of Devonian volcanic rock was due he intrusive granites of Hercynian age. The following phases of mineraliza- are distinguished: (1) magnetite, molybdenite; (2) pyrite, blende, chalco- ite. S. I. T.

EVCHENKO (E. V.) & MONICH (V. K.)] Шевченко (Е. В.) и Монич (В. К.). К минералогии и геохимии свинцоворудного месторождения Миргалимсай в южном Казахстане. Доклады Акад. Наук СССР, 1943, vol. 41, pp. 32–35.
VCHENKO (E. V.) & MONICH (V. K.). *Mineralogy and geochemistry of the lead-ore-bearing deposit Mirgalimsay in south Kazakhstan.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1943, vol. 41, pp. 30–32.

he fine-grained disseminated ore is bedded in Devonian limestone, and is of rothermal metasomatic origin. The limestone is dolomitized and replaced by yte with some ankerite and witherite. Then followed deposition of sulphides— na, blende, and pyrite, with little chalcopyrite and tetrahedrite, and a second

deposition of the same minerals in veinlets with later calcite and aragoni Oxidation yielded ochres with some chalcosine. L. J. S.

Henderson (J.). *Cinnabar at Puhipuhi and Ngawha, north Auckland.* New Z land Journ. Sci. Techn., Sect. B, 1944, vol. 26, pp. 47–60, 2 figs.

Modriniak (N.). *Geophysical investigation of the Puhipuhi mercury deposit.* Ibi pp. 61–65, 1 fig.

Finely disseminated cinnabar occurs with chalcedonic silica and marcasite connexion with younger basalt outcrops and thermal springs. Details are giv of occurrences at Puhipuhi in silicified slope deposits of an old land surface un a cover of basalt; Mount Mitchell in sinter deposits on the present surf Ngawha in silicified grits and sands of an old lake basin. Deposition of cinna took place at low temperatures and pressures. Basalt altered by thermal spr is not detected by a magnetic survey. [M.A. **8**–42.] L. J. S.

Raynaud (J.). *Le minerai de la mine d'Almaden* (*Espagne*). Ann. Soc. Gé Belgique, 1941, vol. 64 (for 1940–41), Bull. pp. B 226–B 237, 4 figs.

Veinlets of cinnabar with some native mercury occur in beds of quartzite. T quartzite was formed by the silicification of Silurian sandstone and was su sequently subjected to sericitization and pyritization. Then followed hyd thermal deposition of cinnabar, together with zeolites, replacing quartz an pyrite, and a later deposition of quartz. L. J. S.

Mikami (Harry M.). *World iron-ore map.* Econ. Geol., 1944, vol. 39, pp. 1–2 1 map (21 × 14 inches).

The distribution of estimated ore reserves (actual and potential, with % F is mapped and tabulated by countries; the world-totals are 35,240 and 164,8 million tons, respectively, with 30–60 % Fe. M. A. P.

Trotter (F. M.). *The origin of the west Cumberland haematites.* Geol. Mag. Her ford, 1945, vol. 82, pp. 67–80, 1 pl., 1 text-fig.

The rival theories, (1) leaching of overlying New Red rocks by descendi meteoric waters, (2) ascending magmatic solutions, are discussed and addition evidence is produced in favour of the second. In addition to metasomat replacement of limestone there must have also been direct precipitation of Fe_2C Solutions of $FeCl_3$ can take up considerable amounts of Fe_2O_3 either as ox chlorides or in colloidal solution. The presence of some fluorite, and the repla ment of sandstone by fluorite, suggests reactions with FeF_3. The ore-bodi extend from the Carboniferous Limestone into the adjoining Lower Permi breccias ('brockram'). L. J. S.

Slavík (František). *Drobnosti z Barrandienu.* [Short notes from the Barrandian Věda Přírodní, Praha, 1942, vol. 21, pp. 26–27, 56–60, 1 fig.

Additional notes on the iron-ores and associated sediments of the Barrandia formations (Algonkian to Devonian) confirm the view of sedimentary, not met somatic, origin of the oolitic ores [M.A. **1**–264]. The oolitic limestone recentl found by F. Prantl at Karlík, south-west of Praha, belongs to a younger stratigra phical horizon than the oolitic ores and differs structurally from the chamosit

ılybite ores of Nučice and other localities. In ferruginous quartz from Ouzký ıe near Holoubkov (between Praha and Plzeň) haematite with rims of goethite)ears as microscopic aggregates similar to the chlorite minerals in moss-agates; admixture of iron oxide acts here as a 'protecting colloid', the pure quartz ng always of coarser crystalline structure than that penetrated by iron-ores.

F. S.

UNMARK (Sven). *Über rezente Eisenocker und ihre Mikroorganismengemeinschaften.* Bull. Geol. Inst. Univ. Upsala, 1943, vol. 29, pp. 1–285, 8 pls., 23 text-figs.

Iicro-organisms in great variety play an important part in the deposition of hydroxide [limonite, limnite, bog-iron-ore] in streams, lakes, bogs, moors, over a wide area in south Sweden. L. J. S.

ARITZKY (A. N.) Заварицкий (А. Н.). К методике изучения качества железных руд.—*Méthode des recherches de la qualité des minerais de fer.* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1939, no. 2, pp. 27–36, 7 figs. (No summary.)

new method of graphical representation of the chemical composition of iron- is is proposed. It is a combination of a triangular diagram with vector repretation, by means of which eleven components can be plotted. S. I. T.

)GOVER (G. B.)] Роговер (Г. Б.). Медноколчеданное месторождение Блява. [*The Blyava cupreous pyrites deposit.*] Moscow & Leningrad (ГОНТИ), 1939, 135 pp., 10 pls., 47 text-figs. Price 7r. 60k. (Russian only.)

'his monograph of the Central Geological Administration gives a comprehen- e account of the large copper deposits in the Blyava district (51°–52° N., 10′–57° 50′ E.) on the western slopes of the southern Urals. The country- ks are dominantly diabases, spilites, albite-porphyrites, and keratophyres, taining adjacent to intrusions of quartz-keratophyre mineralized zones with nikovite, pyrite, marcasite, enargite, chalcopyrite, covelline, and blende. anterite, fibroferrite, pisanite, and chalcanthite are prominent in the zone eaching, while towards the surface jarosite-rich rocks intervene between the -bodies and the wall-rocks. A metallographic study of the ores is included.

C. F. D.

VENKO (V.). *Bakırlı pirit madenleri bölgesi Giresun vilâyetinde Esbiye ve Görele dolaylarındaki Karaerik, Ağlık, İsrail, ilh. madenleri.—Région des mines de pyrite cuivreuse de Karaerik, d'Ağlık, d'İsrail et d'autres mines des environs d'Esbiye et de Görele (vilâyet de Giresun).* Maden Tetkik ve Arama Enstitüsü Mecmuası, Ankara, 1943, vol. 8, pp. 192–222, 1 map, 8 text-figs. (Turkish with French translation.)

Several small mines have been worked for cupriferous pyrite to the west of the n of Trabzon (Trebizond) on the coast of the Black Sea. The veins occur as lacements of Upper Cretaceous andesites and dacites, with some quartz as gue. The ore contains 0·10–0·25 % Cu, and there are some veinlets of chalcoite. L. J. S.

[Zavaritzky (A. N.)] Заварицкий (А. Н.). О некоторых особенностях колчед... ных месторождений Блява, Сибай, Учалы.—Zavaritsky (A. N.). *certain peculiarities of the Bljava, Sibay, Uchali pyrites deposits.* Изв. Ак... Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1943, no. ... pp. 3–13. (Russian with English summary.)

Unlike the pyrite deposits of the middle Urals region, which occur ar... quartz-sericite- and chlorite-schists, the pyrite deposits of the southern U... occur in association with pyroclastic breccias of a keratophyre-spilite vol... complex of Upper Silurian to Lower Devonian age. Pyrite, commonly in the f... of pentagonal dodecahedra, occurs in association with marcasite, blende, w... zite, and melnikovite, and frequently shows colloform structure. It is sugg... that all the Uralian ores of this type were originally formed from magm... emanations related to volcanic activity. At a later date in some districts the ... were subjected to dynamometamorphism under the influence of which ... volcanic rocks were transformed into schists and the ore was partly redepo... and recrystallized. S. I. T...

Ivanov (S. N.) Иванов (С. Н.). Новые данные о генезисе колчеданных местор... дений среднего Урала. *New data on the genesis of pyrite deposits of the m... Urals.* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, S... Géol.), 1943, no. 1, pp. 20–24, 2 figs. (Russian with English summary.)

Cubic crystals of pyrite on etching with ammonia show distinct zonality ... reveal an early form of pentagonal dodecahedra. This observation suppo... Zavaritzky's theory of pyritic ore formation in the Urals, according to which ... original volcano-emanational deposits were subsequently dynamometamorphos... S. I. T...

[Zavaritzky (A. N.)] Заварицкий (А. Н.). О некоторых доводах в поль... дорудного и послерудного метаморфизма сланцев, среди которых залега... колчеданные месторождения.—Zavaritsky (A. N.). *Certain arguments ... behalf of before and after-ore metamorphism of schists among which py... deposits are bedded.* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. S... URSS, Sér. Géol.), 1943, no. 1, pp. 25–41. (Russian with English summar...

A complete review of the theory of formation of the Uralian pyritic deposit... given. Certain features, such as the lense-shaped and banded ore-bodies, cr... cutting veinlets, &c., are explained as being due to the metamorphic differentiati... Relics of primary ores found among the metamorphosed ore gives an additio... support to the theory proposed in 1936 by the author. S. I. T...

[Zavaritzky (V. A.)] Заварицкий (В. А.). Обломочно-вулканические породы ... колчеданном месторождении Блява (Ю. Урал).—Zavaritsky (V. A... *Clastic-volcanic rocks in the Bljava pyrite deposits, South Urals.* Изв. Ак... Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1943, no. ... pp. 47–58, 6 figs. (Russian with English summary.)

A description is given of the keratophyre-spilite volcanic complex and especia... of the pyroclastic deposits which enclose the pyritic ores. The main object of t... paper is to show that the breccias are of volcanic and not tectonic origin.

S. I. T...

VARITZKY (V. A.)] Заварицкий (В. А.). Некоторые данные о геологии Учалинского колчеданного месторождения.—ZAVARITSKY (V. A.). *Some data on the geology of the Uchalinsky pyrite deposit.* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1943, no. 1, pp. 59–70. (Russian with English summary.)

lore data is provided in support of A. N. Zavaritsky's theory of the genesis of Uralian pyrite deposits. The type of pyrite deposit in this paper is intermediate between the highly metamorphosed northern Uralian type and the htly metamorphosed southern type. Spilites, metabasalts, albitophyres, and s occurring in this deposit, in spite of their metamorphism, clearly show relic ures and structures. S. I. T.

OVNIK (N. I.) Наковник (Н. И.). Новое в минералогии боковых пород колчеданных залежей Урала.—*The new in the mineralogy of the lateral rocks of pyrite deposits in the Urals.* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1943, no. 1, pp. 71–73. (Russian with English summary.)

description is given of diaspore, pyrophyllite, topaz, and chalybite, which developed in schists enclosing pyrite deposits near the contact with granite. S. I. T.

SMAN (A. E.) Ферсман (А. Е.) [1883–1945]. Геохимия кобальта.—*Geochemistry of cobalt.* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1939, no. 3, pp. 7–23. (Russian with English summary.)

he geochemistry of cobalt is discussed in the light of energetics and its geonical history is outlined with a view of planned prospecting. S. I. T.

RASIK (M. A.)] Карасик (М. А.). О кобальтовых месторождениях Союза в связи с некоторыми особенностями генезиса кобальтовых руд.—KARASSIK (M. A.). *On the cobalt deposits of the USSR in connection with some peculiar features of cobalt ore genesis.* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1939, no. 5, pp. 42–70. (Russian with English summary.)

review of deposits of cobalt-ore in the USSR is given, a genetic classification posed, and geochemical relations outlined. One peculiar feature of cobalt sits is their isolation in space from the remaining ores of the deposit and the uent association of cobalt sulpharsenides and arsenides with chlorine and n. S. I. T.

ZBURG (I. I.) & SAVELIEV (I. I.) Гинзбург (И. И.) и Савельев (И. И.). Образование никелевых месторождений силикатных руд на южном Урале.—*The formation of nickel deposits of silicate ores in the south Urals.* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1939, no. 6, pp. 119–140, 1 pl., 2 text-figs. (Russian with English summary.)

ne process of formation of nickel ores in the southern Urals is discussed particular attention is devoted to the study of the process of enrichment etermined by the geological and geochemical factors. [M.A. 7–300, 437; , 331.] S. I. T.

Korin (I. Z.) Корин (И. З.). Халиловское месторождение никеля и услов его образования.—*The Khalilovo nickel deposit and the conditions of its for tion.* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Ge 1939, no. 6, pp. 141–158, 1 pl., 4 text-figs. (Russian with English summa

This is a detailed study of the weathering horizons of the Khalilovo (S. Ur nickel deposit [M.A. 7–300]. The processes of weathering of the serpenti which mainly consist of nontronitization and the migration of oxides, are cussed in their relation to the climatic and geological factors. S. I. T

Nalivkin (D. V.) Наливкин (Д. В.). О геологическом строении Айдырлинс никелевого месторождения.—*On geological structure of Aidyrla nickel dep* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 19 no. 6, pp. 3–6. (Russian with English summary.)

The high-grade nickel deposit of Aidyrla in the Urals belongs to the sw type of deposits formed in karst funnels at the junction between the U Mesozoic and the Upper Tertiary. [M.A. 6–150.] S. I. T

[Ginzburg (I. I.)] Гинзбург (И. И.). Новоайдырлинское месторожде никелевых сульфидов осадочного происхождения.—Ginsburg (I. I.). *N Aidyrla deposit of nickel sulphide of sedimentary origin.* Изв. Акад. Н СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1943, no. 6, pp. 27, 3 figs. (Russian with English summary.)

Nickel minerals occur disseminated in clays of Mesozoic and Tertiary overlying the contact zone between serpentinite and limestone in south Ur Some of the richest deposits of nickel are found in clay-infilled karst funn The sulphides are represented by pyrite, marcasite, melnikovite, bravo millerite, and violarite. The less-abundant silicates are garnierite, aidyr nontronite, and ferri-halloysite. The genetic stages of the deposit are sugges as follows: weathering of the nickel-bearing serpentinite with the formation a nickel-enriched nontronitic crust of weathering, denudation of the crust weathering, and deposition of nickel sulphides from solution under the influe of hydrogen sulphide. [M.A. 7–300.] S. I. T

[Katz (A. L.)] Кац (А. Л.). Кора выветривания в районе Крестовско-Тюлен ского никелевого месторождения.—Kaz (A. L.). *The weathering crust of Krestovsko-Tulenian nickel deposit.* Изв. Акад. Наук СССР, Сер. Геол. (B Acad. Sci. URSS, Sér. Géol.), 1943, no. 6, pp. 112–124, 4 figs. (Russian w English summary.)

This is the study of the crust of weathering containing nickel silicates derived from serpentinites and other igneous rocks in the middle Urals. S. I. T

Krotov (B. P.). *On the type of complex deposits of iron, nickel and cobalt ores the Urals.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1945, vol. 47, pp. 46–

Iron-ores containing variable amounts of Cr, Ni, and Co occur as weathe crusts on serpentine or in pockets in adjoining limestone. Some can be used ores of Cr, Ni, or Co; others can yield an iron containing these elements. [M 9–23.] L. J. S

OR (Charles Alfred). *Bravoite from a new locality.* Econ. Geol., 1943, vol. 38, pp. 399–407, 7 figs.

ickel-cobalt ores from Madison Co., Missouri, contain siegenite, linnaeite, casite, pyrite, chalcopyrite, blende, and galena. Under high magnification te crystals show violet borders and cores which are considered to be bravoite $Fe)S_2$ rather than violarite $(Ni,Fe)_3S_4$ or nickeliferous pyrite. [Min. Mag. 309; M.A. 8–285.] M. A. P.

RREN (H. V.) & THOMPSON (R. M.). *The mineralogy of two cobalt occurrences in British Columbia.* Bull. Inst. Mining Metall. London, 1945, no. 470, 18 pp., 2 pls.

the Nickel Plate mine, Hedley, the ore contains löllingite-safflorite, cobaltite, and at the Little Gem prospect, Lillooet district, löllingite-safflorite, danaite, ickel, &c. L. J. S.

TOV (Ivan). *Manganese ore deposits.* Mining Mag. London, 1944, vol. 71, pp. 329–344, 5 figs.

revised, genetic classification of manganese ore-deposits is proposed based comprehensive study of the published descriptions of most of the important urrences. A useful list of 89 references to literature is given. Geographical ribution is briefly considered and 9 ore-provinces are recognized. W. C. S.

KERSLOOTH (P. de). *Batı ve orta Anadolunun geniş mânada rüsubî manganez cevheri yatakları.—Über die im weiteren Sinne sedimentären Manganerzlagerstätten West- und Zentralanatoliens.* Maden Tetkik ve Arama Enstitüsü Mecmuası, Ankara, 1943, vol. 8, pp. 91–109, 1 map, 2 pls. (Turkish with German translation.)

anganese ores of sedimentary origin in Anatolia are in three regions. (1) The hern (or Pontian) province along the coast of the Black Sea, and extending a Bulgaria to the Caucasus. Lenses of pyrolusite and psilomelane with jasper ır between Upper Cretaceous marls and andesite lavas and tuffs. It is sug-ed that manganese from the andesites was deposited in the sea and afterwards centrated by migration, and that the ore is of sedimentary-metasomatic origin. this province there is also a limited inner zone, north-east of Ankara, asso-ed with Upper Jurassic to Lower Cretaceous beds and basic rocks (serpentine, ite, diabase, and spilite). (2) The southern (or Tauridian) province extending ıg the south coast, with pyrolusite and psilomelane and some rhodochrosite, nuch the same character as the inner zone of the northern province. (3) The tral province, west of Ankara, in Palaeozoic rocks with radiolarite and sub-ine diabase and spilite, is intensely metamorphosed by a large mass of talline rocks. The ore here was originally as in (1) and (2) but has been tly metamorphosed to braunite, with some remnants of pyrolusite and omelane, together with rhodonite, rhodochrosite, manganophyllite, and ıgancrocidolite. Later retrograde metamorphism or weathering gave rise to cond generation of pyrolusite and psilomelane. (1) and (2) are involved in Alpine folding and (3) in the Hercynian. In addition to these sedimentary there are other manganese ores of less importance associated with Pb–Zn–Fe of hydrothermal origin in connexion with Tertiary lavas. L. J. S.

Kleinsorge (H.). *Malatya'nın bazı fosilli manganez cevherleri üzerinden mi[kro]skopik ve jenetik müşahedeler.—Erzmikroskopische und genetische Bet[rach]tungen über einige fossil-führende Manganerze aus Malatya, Türkei.* M[aden] Tetkik ve Arama Enstitüsü Mecmuası, Ankara, 1943, vol. 8, pp. 265–267, 1 (Turkish with German translation.)

Manganese deposited with radiolarite had been concentrated as pyrol[usite]. Radiolaria in the ore show a skeleton of pyrolusite and a core of quartz, or v[ice] versa. L. J. S.

[Zagyansky (A. L.).] Загянский (А. Л.). О генетических особенностях мар[ган]цевых руд Полуночного месторождения. Доклады Акад. Наук СССР, 19[43], vol. 41, pp. 228–230, 2 figs.

Zaghiansky (A. L.). *On the genetic peculiarities of the manganese ores of [the] Polunochny deposit.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1943, vol. [41], pp. 216–218, 2 figs.

This deposit in Palaeozoic rocks in the northern Urals consists in the western p[art] of primary oxides (pyrolusite and wad), deposited in shallow water near a sh[ore] line; eastward they grade into carbonate ores (mangano-dolomite, oligonite, [and] calcite-rhodochrosite), deposited in deeper water; and still farther east carbo[nate] ores with opal. L. J. S.

Mikhailov (P. P.). *The Murzhik deposit of manganese ores.* Compt. Re[nd.] (Doklady) Acad. Sci. URSS, 1945, vol. 48, pp. 50–52.

In the Murzhik Mts. (270 km. from Zhana-Semey station on the Turk[estan]-Siberian railway, and 150 km. from Maiskoye wharf on the Irtysh riv[er]) metamorphosed manganese ores (Mn 20–35 %) occur between Devonian a[nd] Carboniferous beds. The minerals are psilomelane, wad, pyrolusite, braun[ite], rhodochrosite, with calcite, baryte, &c. L. J. S.

Betekhtin (A. G.). *On metamorphosed manganese deposits.* Compt. Re[nd.] (Doklady) Acad. Sci. URSS, 1945, vol. 46, pp. 24–26.

Bedded ores deposited as hydroxides become changed to anhydrous oxides [by] dynamometamorphism and migrate to fissures and fault planes. At shall[ow] depths pyrolusite is formed, at greater depths braunite and hausmannite, [and] in extreme cases silicates. L. J. S.

Betekhtin (A. G.). *On a new manganiferous province in the south Urals.* Com[pt.] Rend. (Doklady) Acad. Sci. URSS, 1945, vol. 47, pp. 43–45.

The well-known provinces are: (1) Tertiary-Quaternary of south Russia a[nd] Transcaucasia; (2) Devonian near Magnitnaya. A third of Lower Carbonifer[ous] age is distinguished near Magnitogorsk, Asha, &c., with manganese-garnet a[nd] rhodonite as the primary minerals in siliceous shales and jaspers. L. J. S.

Hendricks (Thomas A.) & Laird (Wilson M.). *The manganese deposits of [the] Turtle Mountains, North Dakota.* Econ. Geol., 1943, vol. 38, pp. 591–60[8], 1 fig.

The low-grade ore (average 10 % Mn) is a calcareous tufa containing flaky, so[ft]

vnish-black rancieite (X-rayed), deposited around cold springs in NW. tte Co. and NE. Bottineau Co. Analysis by M. Fleischer of a flotation concen- containing 3·31 % CaO as $CaCO_3$ gave MnO_2 66·26, MnO 1·37, Al_2O_3 0·19, $)_3$ 0·30, MgO 0·97, CaO 9·43, Na_2O 0·74, K_2O 0·74, H_2O+ 10·45, H_2O- 3·95, none, CO_2 2·60, P_2O_5 none, NiO 0·12, CoO 0·06, BaO 0·07, Li_2O 0·005, none, PbO 0·05, Bi_2O_3 0·17, insol. (largely organic matter) 3·65, total ·42', and the formula $(Ca,Mn^{II})Mn^{IV}_4O_9.3H_2O$. M. A. P.

(W. E.) & Oakes (M. C.). *Manganese deposits of the Bromide district, Oklahoma.* Econ. Geol., 1944, vol. 39, pp. 412–443, 9 figs.

ne ores are manganiferous carbonates with manganite and hausmannite and r amounts of neotocite and bementite. Neotocite has n 1·598 and sp. gr. 2·95. um rhodochrosite (anal. I) containing 65·91 $MnCO_3$ gave ω 1·763. Other onates recorded in the ore are manganocalcite and ankerite. Manganite, ified by X-ray, occurs as thick fibres and as very finely granular massive egates. The massive habit has not been recorded previously. Hausmannite not identified in the hypogene ore by the X-ray examination, but was found sidual nodules, and is believed to occur in the primary ore. Psilomelane and lusite are also recorded. The ore forms small replacement bodies in Silurian stone and is believed to have been deposited by warm meteoric waters that leached Mn from local sedimentary rocks.

CaO.	MgO.	FeO.	Fe_2O_3.	MnO.	CO_2.	insol.	Total.
14·07	2·16	0·68	—	40·67	39·12	4·16	100·86

W. C. S.

ens (Rollin E.). *Composition of some chromites of the western hemisphere.* Amer. Min., 1944, vol. 29, pp. 1–34, 5 figs.

fty-two complete and 114 partial chemical analyses are given of purified erial from chromite deposits in North, Central, and South America, the several ities being indicated on a map. The general formula is $(Mg,Fe)O.(Cr,Al,Fe)_2O_3$ six end-members, ferrochromite ($FeCr_2O_4$), magnesiochromite ($MgCr_2O_4$), el ($MgAl_2O_4$), hercynite ($FeAl_2O_4$), magnesioferrite ($MgFe_2O_4$), and magnetite $'e_2O_4$), which are placed at the corners of a triangular prism. The plotted yses show in nearly all cases MgO to be in excess of FeO, and Al_2O_3 in excess e_2O_3 (aluminian chromite and ferrian chromite). Cell-sizes range along a ght line from 8·175 Å. with Cr_2O_3 22·76 % to 8·301 Å. with Cr_2O_3 59·5 % (for el a 8·1 and for magnetite 8·4 Å.). L. J. S.

enko (V.). *Türkiyede filon şeklindeki bazı krom yatakları ve bunların teşekküllü. —Quelques gîtes de chromite en forme de filons et leur genèse (Turquie).* Maden Tetkik ve Arama Enstitüsü Mecmuası, Ankara, 1943, vol. 8, pp. 59–90, 2 maps, 2 pls. (Turkish with French translation.)

asses and schlieren veins of chromite at Guleman and Soru Dağ occur in ntinized dunite, harzburgite, and lherzolite intrusive into Miocene and Eocene . Analyses gave Cr_2O_3 43·31–52·8, Al_2O_3 6·04–19·45, Fe_2O_3 13·34–17·00, 17·05–20·50, CaO nil–4·87, indicating chrompicotite rather than magnomite. L. J. S.

Wijkerslooth (P. de). *Anadolu krom cevherleri üzerinde mikroskopik tetkikler. Mikroskopische Beobachtungen an Anatolischen Chromerzen.* Maden Tet ve Arama Enstitüsü Mecmuası, Ankara, 1943, vol. 8, pp. 254–264, 2 (Turkish with German translation.)

Three classes of enclosures in Turkish chromite ('Kromspinel', 'Chromspi [not chrome-spinel = picotite] are distinguished. (1) Foreign materials of e or contemporaneous crystallization, including olivine crystals, needles of rutil and minute octahedra of platinum. (2) Exsolution materials, including haem and magnetite parallel to (111) of the chromite. (3) Later introduced mate including silicates of metamorphic origin, such as chlorite, mica, garnet, tremolite, which are often chrome-bearing, giving kämmererite, chrompher uvarovite, and chromtremolite; also metallic sulphides of pneumatolytic-h thermal origin, such as chalcopyrite, pyrrhotine, and nickel minerals. Resor of chromite took place at two periods. (1) During the magmatic phase, w rounding of the crystals producing globular forms with smooth surfaces During a later hydrothermal-metamorphic phase, producing jagged surfaces penetrating along crevices often parallel to (111), with the production of chlor serpentine, and tremolite. Between these silicates and the chromite the sometimes a narrow zone of lighter coloured and more highly reflecting mat called 'Ferritchromit' (K. Spangenberg, 1943), which is considered to be rich Fe and Cr, due to the transference of Al and Mg to form the silicates. L. J. S

Ladame (Georges). *Recherches sur la concentration mécanique des chromites Guleman et du Soridağ, Turquie.* Compt. Rend. Soc. Physique Hist. N Genève (Suppl. Arch. Sci. Phys. Nat., ser. 5, vol. 25), 1943, vol. 60, pp. 2 232.

Six chemical analyses of the crude ore, mixed with serpentine, actinolite, talc, are recalculated to chromite, picrochromite, spinel, and magnetite m cules: e.g. I, from Soru Dağ; II, from Guleman. The Soru Dağ ores are sligh magnetic and can be separated magnetically, yielding 58–60 % Cr_2O_3, w those from Guleman can only be concentrated by vanning, yielding 49–52 Cr_2O_3.

	Cr_2O_3.	Al_2O_3.	FeO.	MgO.	CaO.	SiO_2.	ign.	Total.	$FeCr_2O_4$.	$MgCr_2O_4$.	$MgAl_2O_4$.	FeFe
I.	57·92	9·85	16·79	11·63	0·14	1·13	0·15	97·61	45·82	33·72	13·75	2·1
II.	41·96	15·24	14·37	13·90	0·74	11·03	2·69	99·93	45·07	14·22	21·29	—

L. J. S

Bateman (J. D.). *Composition of the Bird river chromite, Manitoba.* Amer. M 1945, vol. 30, pp. 596–600, 1 fig.

Large deposits of chromite were discovered in 1942 [M.A. **9**–66] in a compo sill, 500–3500 feet thick, consisting of an upper sheet of hornblende-gabbro a a lower sheet of serpentinized peridotite and pyroxenite. Seven analyses R. J. C. Fabry of ore concentrates show Cr_2O_3 39·60–43·50, Al_2O_3 8·85–17· Fe_2O_3 7·20–21·73, FeO 20·36–30·04, MgO 2·26–8·86 %, &c., corresponding Cr_2O_3.(Fe,Mg)O 57·81–62·58 %. The lower-grade ore shows an excess of Fe_2 and polished sections show an exsolution of haematite as blades in two directi at right angles. L. J. S

HNSTON (W. D., *Jr.*) & SOUZA (H. Capper A. de). *Layered or banded chromite at Campo Formoso, Baía, Brazil.* Econ. Geol., 1943, vol. 38, pp. 287–297, 9 figs.

The layers of chromite, a few millimetres to over a metre in thickness, separated layers of serpentine after olivine, are remarkably persistent in thickness, gesting that they formed by alternating showers of chromite and olivine stals on the floor of a magma chamber. Three analyses by R. E. Stevens of omite concentrates give Cr_2O_3 56·24–58·60, Al_2O_3 11·08–12·42, Fe_2O_3 3·46–4, FeO 12·06–12·72, MgO 12·47–13·57, MnO 0·15–0·37, TiO_2 0·15–0·21, CaO 4–0·12, SiO_2 0·22 0·38, H_2O 0·26–0·44%. M. A. P.

IZA (Henrique C. A. de). *Cromo em Pũi-E* [i.e. Piuí] *de Minas Gerais.* Rev. Brasil. Quím., 1944, vol. 18, pp. 216–220.

Chromite occurs in chlorite-talc-schist derived from serpentine. Partial analyses several ore samples show Cr_2O_3 36·0–48·5, FeO 13·8–24·8, MgO 8·6–13·8 %. L. J. S.

CHAUSEN (M. N.). Альтгаузен (М. Н.). *New data on the occurrence of tin in central Kazakhstan.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1940, vol. 27, pp. 140–141.

ndications of tin ores are found near granite masses over a wide area, with urrences of cassiterite in pegmatite, greisen, quartz veins, iron-ore skarns, in copper deposits. L. J. S.

TMAN (Y. D.)] Готман (Я. Д.). К вопросу об оловоносных интрузиях Приморья.—GOTMAN (J. D.). *On the tin bearing intrusions in the Maritime Province (the Far East).* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1943, no. 6, pp. 89–97, 4 figs. (Russian with English summary.)

petrographical description of granites, norites, and porphyrites found in the divostok district of Siberia is given and their genetic connexion with the iiterite-bearing veins suggested. S. I. T.

LWELL (F. L.) & EDWARDS (A. B.). *Mineral composition of the tin ores of Renison Bell, Tasmania.* Proc. Australasian Inst. Mining & Metallurgy, 1943, nos. 131–132, pp. 173–186, 4 pls.

xamination of polished sections of the ore showed cassiterite, mispickel, te, and pyrrhotine as the chief minerals, with smaller amounts of marcasite, copyrite, stannite, native bismuth, blende, tetrahedrite, jamesonite, galena, rgyrite, canfieldite (giving etching tests similar to argyrodite, but spectro-ic analysis showed no Ge), franckeite (replacing stannite), gold, and magnetite. gangue mineral is mainly quartz, with some tourmaline, topaz, and carbo-es. L. J. S.

SHENTZOV (A. G.). *Tin minerals in the Maikhura skarn deposit (Ghissar range).* Compt. Rend. (Doklady) Acad. Sci. URSS, 1945, vol. 47, pp. 494–496, 1 fig.

he skarns at this locality in Central Asia, occurring at the contact of grano-ite and limestone, consist of garnet, pyroxene, epidote, and quartz with elite. They are intersected by later hydrothermal veins (which also penetrate

the granodiorite) consisting of quartz, oligoclase, and phlogopite, with scheeli cassiterite, pyrite, pyrrhotine, blende, chalcopyrite, and microscopic grains stannite. The cassiterite is of two types: larger (up to 5 cm. long) light br crystals; and smaller black crystals and grains. Analysis by E. F. Ziv g SnO_2 97·9, SiO_2 0·58, TiO_2 0·25, Nb+Ta 0·08, ZrO_2 0·06, Al_2O_3 0·11, FeO 0 MnO trace, MgO 0·04, CaO 0·07, S 0·18 = 99·49. L. J. S.

Franco (Ruy Ribeiro). *A faixa estanifera do Rio Grande do Sul.* Bol. Fac. F Ciênc. Let. Univ. São Paulo, 1944, no. 44 (Mineralogia no. 6), 54 pp., 1 (map), 41 text-figs. (English summary, pp. 51–52.)

The granite mass intruded into schists and quartzites in the Encruzilhada Piratini districts consists of a core of fine- to medium-grained biotite-granite intermediate zone of muscovite-biotite-granite, and an aureole of musco granite with very little biotite. The last is followed by veins of aplite, pegma and quartz; and later greisenization with tourmaline, fluorite, and twin crystals of cassiterite, in both the granite and the schists. The distribution of t different minerals in the veins is illustrated by sketches. L. J. S.

Turneaure (F. S.) & Gibson (Russell). *Tin deposits of Carguaicollo, Bol* Amer. Journ. Sci., 1945, vol. 243 A (Daly volume), pp. 523–541, 3 pl 2 text-figs. (map).

Teallite is the principal ore-mineral in the Sn–Ag veins in altered dac porphyry at Carguaicollo, dep. Potosi. It forms coarse laths or plates in ban 1–5 cm. wide near the walls of the veins. Spectrographic and microchemical te show the presence of much silver but no zinc, which is not in agreement with reported occurrence at this locality of pufahlite or zinc-teallite [M.A. 3–27 Some franckeite is also present as very small wisps or feathery grains. Teallit the earliest of the ore-minerals, is largely replaced by an aggregate of wurtzi and blende or by pyrite and marcasite. By oxidization it is altered to a fi grained aggregate of cassiterite and galena, with associated anglesite, jarosi plumbojarosite, and limonite. L. J. S.

Jones (O. A.). *The tin, tungsten, and molybdenum deposits of Australia. annotated bibliography with a discussion of the geology of the deposits and the problems connected with their mining.* Univ. Queensland Papers, De Geol., 1944, new ser., vol. 2, no. 9, 49 pp., 2 figs.

A bibliography of 230 items arranged chronologically (1872–1942) is supp mented with abstracts and a detailed index of localities. Notes are added on t types of ore-deposits, and a list of minerals includes cassiterite, stannite, wolfra ite, scheelite, hübnerite, molybdenite, molybdenum oxide, wulfenite, ilsema nite, and an unnamed molybdate of iron, together with many associated minera L. J. S.

Li (K. C.) & Wang (Chung Yu). *Tungsten. Its history, geology, ore-dressi metallurgy, chemistry, analysis, applications, and economics.* New York (Rei hold Publishing Corpn.), 1943, xvii+325 pp., 3 col. pls., 29 text-figs. Pri $7.00.

A useful book, the scope of which is indicated fully in the title. In t

ɔter on geology the tungsten mines of the world and their mineralogy described (some of them very briefly). There is a very full account of the ıese mines, which country during 25 years, 1913–1937, contributed 40–85% rage 37%) of the world's production. The chapter on economics gives :uctive charts and tables of production and prices. W. C. S.

PLETSKY (B. M.)] Куплетский (Б. М.). Новые месторождения вольфрама на Среднем Урале. Доклады Акад. Наук СССР, 1943, vol. 40, pp. 324–326.
LETSKY (B.). *New tungsten deposits in the middle Urals.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1943, vol. 40, pp. 285–287.

olframite occurs in quartz veins at many places along the margin of the large inka-Konev granite massif, but only the deposits at South Konev and ıssev are of economic importance. L. J. S.

ISHTEDT-KUPLETSKAYA (E.)] Бонштедт-Куплетская (Э.). К минералогии Карасьевского и Юго-Коневского вольфрамовых месторождений на Среднем Урал. Доклады Акад. Наук СССР, 1943, vol. 40, pp. 412–415.
NSTEDT-KUPLETSKAYA (E.). *On the mineralogy of the Karassev and South-Konev tungsten deposits in the central Urals.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1943, vol. 40, pp. 362–364.

ifferent types of quartz veins occur at the greisenized contact of the granite ɔif in the Bagariak district, Cheliabinsk province. The ore is wolframite, with vithout fluorite. Associated minerals are scheelite, pyrite, molybdenite, ıuthite, &c. L. J. S.

ɔULLAEV (K. M.)] Абдуллаев (Х. М.). Генезис шеелитового оруденения в скарнах Лянгарского месторождения.—ABDULLAIEV (H. M.). *Genesis of scheelite mineralization in the skarns of the Liangarsky deposit.* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1941, nos. 4–5, pp. 75–96, 3 figs. (English summary, pp. 95–96.)

ıe scheelite-bearing skarns (tactites) of Lyangar, Ak-Tau Mts., Uzbekistan, described. They occur in marble along the contact with adamellite. The wing genetic stages are distinguished: (1) thermal-metamorphic stage, ɛsponding to the formation of marble and calc-silicate hornfels; (2) skarn ɛ, corresponding to metasomatic replacement with the resulting formation iopside-, hedenbergite-, and grossular-skarns; (3) hydrothermal, post-mag-c stage, corresponding to the sulphide mineralization and the formation of elite, molybdenite, mispickel, blende, pyrrhotine, sericite, and calcite. To type of deposit, which could not be called metasomatic, the author applies ɛerm of skarn type. S. I. T.

ɔFEEV (V. D.) Тимофеев (В. Д.). Поисковые признаки на шеелит в скарнах Минусинского района.—*The scheelite content prospecting indications in the skarns of the Minusinsk region.* Изв. Акад. СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1939, no. 5, pp. 90–110, 1 pl., 4 text-figs. (Russian with English summary.)

southern Siberia the skarns contain 95 different minerals, among which ɔlite is the most important from the economic point of view. The author has

assembled a large number of favourable and unfavourable indications for schee and by means of a diagram has determined the coefficient of probability of sche occurrence for each described locality. [M.A. 8–48.] S. I. T

Hsu (Ke-Chin). *Tungsten deposits of southern Kiangsi, China.* Econ. Geol., 1 vol. 38, pp. 431–474, 16 figs.

From 1918 to 1937 China produced 56 % of the world's tungsten of which 7 came from Kiangsi. The wolframite occurs in veins associated with late Jur granite which invaded folded Palaeozoic and early Mesozoic sediments. A det study gives the paragenetic sequence of 25 pegmatite- and subordinate minerals. M. A. P.

Allen (C. C.) & Folinsbee (R. E.). *Scheelite veins related to porphyry intru Hollinger mine.* Econ. Geol., 1944, vol. 39, pp. 340–348, 5 figs.

Scheelite has been obtained from local concentrations, located by means ultra-violet lamp, in quartz-ankerite and tourmaline-quartz-ankerite vei the Hollinger gold-mine, Timmins, Porcupine district, Ontario. The two type veins are associated with the two main intrusive quartz-porphyry bodies i mine. The tourmaline-bearing veins are related to the larger of the two intrus and carry apatite and albite-oligoclase as well as quartz, ankerite, and schee W. C. F

Wilson (Kenneth L.). *Tungsten deposits of the Darwin Hills, Inyo Cou California.* Econ. Geol., 1943, vol. 38, pp. 543–560, 7 figs.

These scheelite deposits are associated with fracture systems in Pennsylvan limestones which were invaded and metamorphosed by quartz-diorite. Since discovery in 1940 about 31,000 tons of ore (1 % WO_3) have been produced more than 26,000 tons are in sight. Wollastonite, idocrase, grossular, and schee sometimes as half-inch crystals, were followed by pyrite and argentiferous gal M. A. P

White (William A.). *Tungsten deposit near Townsville, North Carolina.* A Min., 1945, vol. 30, pp. 97–110, 9 figs.

Describes a recent discovery in Vance County of hübnerite (WO_3 72 'MnO_2' 25·68, 'Fe_2O_3' 2·45 %) with some secondary scheelite and tungst The occurrence is in quartz veins with fluorite in sericite-schist near granite. L. J. S

Ahlfeld (Federico). *The Chicote tungsten deposit, Bolivia.* Econ. Geol., 1 vol. 40, pp. 394–407, 7 figs.

The district is 65 km. north-north-east of Oruro, on the boundary of departments of La Paz and Cochabamba, and belongs to the northern par the tin-tungsten zone of Bolivia. Mineralized fissures traverse Devonian sh which are altered to quartz-tourmaline rocks in the central part of the area. the veins wolframite occurs with pyrite, arsenopyrite, pyrrhotine (crystals to 5 cm.), chalcopyrite, blende, native bismuth, bismuthinite, and chalyb Tourmaline of three generations occurs on the wolframite, in druses (li yellow, 4 cm.), and in the quartz of the veins. Individual crystals of wolfra

to 10 cm. along the edge are known, and one vein yielded a mass weighing kg. Cassiterite occurs in veins in a peripheral zone and is accompanied by muthinite, pyrite, arsenopyrite, and chalybite. The vein zone has a vertical ige of 1300 metres. The intrusive mass which is supposed to be the cause he mineralization is not exposed. In the valley of the river Ayopaya, which s through the mineralized area, a brecciated talus contains much low-grade lfram ore. W. C. S.

IVA (J. M. Cotelo). *Jazigos portugueses de cassiterite e de volframite.* Comun. Serv. Geol. Portugal, 1944, vol. 25, pp. 1–255, 1 map (1:1,000,000), 45+6 pls., 105 text-figs. English summary: *Portuguese mineral deposits of cassiterite and wolframite*, pp. 233–244.

The ores are of hypothermal origin in pegmatites connected with a large granite ss. Some alluvial deposits are also worked. Detailed descriptions are given of rocks and ores of five districts; followed by accounts of the processes of tization, greisenization, topazization, tourmalinization, apatitization, biotiion, muscovitization, silicification, mineralization, baueritization, fluoritiza-, chloritization, sericitization, carbonatization, and kaolinization. L. J. S.

ARASHVILI (G. I.). Харашвили (Г. И.). Геолого-петрографический очерк Каробского месторождения и условия его формирования.—*Geological and petrographical description of Karobi deposit and conditions of its formation.* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1939, no. 5, pp. 71–89, 7 figs. (Russian with English summary.)

A detailed geological and petrographical description is given of the molybite deposit at Karobi, Georgia, Caucasus. Molybdenite is found in a zone of ified dacite dike of Tertiary age. The ore-minerals besides molybdenite are ite, chalcopyrite, stibnite, and mispickel. The mineralization is attributed pneumatolytic action during the later stages of the solidification of dacitic gma and to the hydrothermal action which was also responsible in the forma- of polymetallic mineralization of breccia and deposition of cassiterite.
S. I. T.

LLETT (R. W.). *A molybdenite-bearing quartz lode, Waiau survey district, Nelson.* New Zealand Journ. Sci. Techn., Sect. B, 1944, vol. 25 (for 1943), p. 91.

ndications of molybdenite in a quartz vein traversing diorite invite prospecting.
L. J. S.

LFF (Paulo Anibal Marques de Almeida). *Molibdenita na Paraíba e no Rio Grande do Norte.* Mineração e Metalurgia, Rio de Janeiro, 1944, vol. 7, p. 357.

Molybdenite as hexagonal crystals around a nucleus of quartz is found in small ntity in pegmatite. Larger amounts (100 kg. in 1914–1915) occur in veins h scheelite and calcite; the scheelite as masses up to 25 kg., those of ½–1 kg. ig common. L. J. S.

ARGO (William Gerson Rolim de). *Sôbre a gênese de uma jazida de molibdenita do Rio Grande do Sul.* Bol. Fac. Fil. Ciênc. Let. Univ. São Paulo, 1945, no. 49

(Mineralogia no. 7), pp. 29–74, 1 pl., 25 text-figs. (Portuguese with Engli summary.)

Molybdenite occurs at Vacacaí, São Gabriel district, in deep-seated quar veins and disseminated in the country-rock of the contact zone between grani and schists. Associated minerals are chalcopyrite, pyrite, gold, bornite, copp magnetite, fluorite, &c. The presence of fluorite suggests that the molybden was deposited by volatile MoF_6 from the granitic magma. L. J. S

Knouse (F. L.). *Jazida de columbita e mica, de Pouso Alegre, Espírito Sa* Mineração e Metalurgia, Rio de Janeiro, 1944, vol. 7, p. 359.

Columbite as fragments up to the size of a fist is found in kaolinized pegmat together with mica. Better quality mica was found in depth. L. J. S.

Catriú (Luiz), *Mina de berilo e columbita de Tanquinhos, Paraíba.* Mineraçã Metalurgia, Rio de Janeiro, 1944, vol. 7, pp. 349–352, 6 figs.

Opaque beryl containing BeO 12 % occurs in pegmatite as prisms up to 1 m long and 5–40 cm. thick. Columbite, of which 10–12 tons have been collect during the past five years, has an average content of Ta_2O_5 45 %, Nb_2O_5 37 %. L. J. S.

Teixeira (Emilio Alves). *Zircônio em Poços de Caldas.* Bol. Divisão de Fomen da Produção mineral, Brasil, 1943, no. 55, 63 pp., 20 pls. (English summary *The zirconium deposits of the Poços de Caldas plateau, Minas Gerais, Bras* pp. 21–23.)

The zirconium ore, caldasite [M.A. **1**-24], a mixture of baddeleyite and zirco occurs in connexion with nepheline-rocks (phonolite, foyaite, and tinguaite) Triassic age in south-west Minas Geraes near the border of São Paulo. It mostly obtained in surface workings from alluvial and eluvial deposits, but no veins are also worked. The principal mines are the Serronte, Cascata district, ar the Alemão (or Taquary), Pocinhos district. The present monthly output about 1500 tons, and since 1909 a total of about 33,000 tons has been produce The composition shown in 25 analyses ranges: ZrO_2 67·95–97·30, SiO_2 0·72–21·3 TiO_2 0·24–2·55, Al_2O_3 0·86–8·99, Fe_2O_3 0·81–5·02, ign. 0·87–4·30 %. The decor position of eudialyte, rosenbuschite, and låvenite by hydrothermal alkali solutions gave rise to the deposition of zirconia along fissures in the nephelin rocks. L. J. S.

Franco (Ruy Ribeiro). *Minerais de zircônio na região de Poços de Caldas, Min Gerais.* Bol. Fac. Fil. Ciênc. Let. Univ. São Paulo, 1945, no. 49 (Mineralog no. 7), pp. 5–28, 19 figs. (Portuguese with English summary.)

A review is given of the literature, together with figures of crystals of zircon a the radially fibrous structures of 'favas' and mamillary caldasite. The mode origin is discussed. L. J. S.

Mawson (Douglas). *The nature and occurrence of uraniferous mineral deposits South Australia.* Trans. Roy. Soc. S. Austr., 1944, vol. 68, pp. 334–35 3 pls., 6 text-figs. (maps).

Geological and mining details are given of deposits in seven districts, the mo

portant of which are Radium Hill and Mount Painter. Chemical analyses are en of the ores, rocks, and associated minerals biotite, monazite, and fergusonite. vidite [Min. Mag. **15**–281] is a homogeneous mineral, perhaps of the perovskite up. L. J. S.

ROPOLSKY (L. M.) Миропольский (Л. М.). О распространении ванадия в каусто-биолитах Татарии.—*On the occurrence of vanadium in the kaustobiolites of Tartaria.* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1939, no. 3, pp. 103–110. (Russian with English summary.)

ata are provided of the amount of V_2O_5 found in coal, bitumen, and oil-shales Tartaria (Volga region of USSR). S. I. T.

DIA (D. N.). *A brief account of the mineralogy of the graphite deposits of Ceylon: a note on the origin of graphite.* Rec. Dept. Mineralogy, Ceylon, 1943, Prof. Paper no. 1, pp. 15–24, 10 pls.

raphite is mined in many small pits over a wide area, where it occurs in veins pockets in granulitic rocks of the Khondalite series. The veins show a banded cture with transversely arranged fibrous graphite along the walls and foliated hite in the middle. Associated minerals are pyrite, quartz, calcite, pyroxene, apatite. In a few cases molybdenite is interleaved in graphite. Disseminated es of graphite also occur in granulites, schists, and crystalline limestones, and egmatite and quartz veins. It is suggested that the graphite intruded into s was formed by the dissociation of CO_2 under high pressure and temperature, CO_2 being from the metamorphic dissociation of limestones, which occur in ciation. L. J. S.

LKOV (Y. A.) & TZVETKOV (A. I.)] Фиалков (Я. А.) и Цветков (А. И.). Характеристика бокситов Вязовского месторождения по данным регистрации кривых нагревания. Доклады Акад. Наук, 1943, vol. 40, pp. 311–314, 1 fig.

KOV (J. A.) & TSVETKOFF (A. I.). *A characteristic of bauxites of the Vyazov deposit according to heating curve records.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1943, vol. 40, pp. 273–276, 1 fig.

eating curves of bauxite from Devonian rocks in the southern Urals show bore as the main constituent. L. J. S.

Э (L. S.). *On the origin of the Ural bauxites.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1945, vol. 46, pp. 154–156.

ie Red Cap (lat. 60° N.) bauxites of Devonian age were deposited in lakes swamps, where alumina and TiO_2 were accumulated by vegetation and bly by bacteria. L. J. S.

A (N. S.)] Ильина (Н. С.). Геология, минералогия и генезис бокситов Буксонского месторождения в восточном Саяне.—ILJINA (N. S.): *The geology, mineralogy and origin of bauxites of the Buksonsky deposit in the eastern Sayan range.* Изв. Акад. Наук СССР, Сер. Геол. (Bull. Acad. Sci. URSS, Sér. Géol.), 1944, no. 1, pp. 83–89. (Russian with English summary.)

posits of compact bauxite interbedded with limestones of Cambrian age are

described. The bauxite is amorphous and cryptocrystalline, stained with ir oxides, and contains diaspore, haematite, leptochlorites, and certain accesso minerals. It is suggested that it was deposited from solutions in a shallow sea S. I. T

Quitzow (Hans Wilhelm). *Die geologische Stellung der ostadriatischen Bauxit kommen.* Zeits. Prakt. Geol., 1944, vol. 52, pp. 11–19, 8 figs.

In the Dinaric mountain belt periods of bauxitization occurred in the U Trias, Cretaceous, Cretaceous-Tertiary, Middle Eocene, and Miocene. A comp hensive description, with bibliography, is given of the important Middle Eo deposits in northern Dalmatia and of the Mostar bauxite field in Hercegovi C. F. D

Knouse (Frederick L.). *Cristal de rocha no Estado do Espírito Santo.* Av Divisão de Fomento da Produção Mineral, Brasil, 1944, no. 55, 16 pp., 6

Rock-crystal occurs in pegmatite and quartz veins, also in geodes in gra and gneiss, at several places. Material is also collected from alluvial depos Since 1937 the total output has been about 40,000 kg. Mention is made of a la crystal weighing 2000 kg. L. J. S

Holloway (H. L.). *Salt deposits of the Dankalian depression.* Mining M London, 1945, vol. 73, pp. 211–216, 8 figs.

Description of salt lake near the Eritrean-Ethiopian frontier containing posits of potash salts, sulphur, and gypsum. Sulphur deposits as encrustations gypsum beds occur at Zariga in Eritrea. The potash deposits are centred arou an island in the salt lake at Dalol on the Ethiopian side of the frontier. Fumaro and small geysers are active on the island. The potash deposit is superficial, 1 20 cm. in depth, and is associated with deposits of sulphur and iron oxychlorid [M.A. **1**–324, **3**–398.] W. C. S

Alstine (R. E. van). *The fluorspar deposits of St. Lawrence, Newfoundland.* Ec Geol., 1944, vol. 39, pp. 109–132, 11 figs.

This important, recently developed deposit near the tip of Burin peninsu south Newfoundland, consists of high-grade (95 % CaF_2) material in veins 5 f thick, low-grade (75 % CaF_2) 15–20 feet thick, mainly in Palaeozoic grani 'Blastonite', a local name for brecciated fluorite in a matrix of cryptocrystalli quartz, with conchoidal fracture, in some places forms up to 10 % of a ve Analysis by G. Kahan of coarse-grained, porphyritic, miarolitic, red alask granite, from Iron Springs mine: SiO_2 78·43, TiO_2 0·12, Al_2O_3 11·25, Fe_2O_3 1· FeO 0·13, MnO trace, MgO 0·01, CaO 0·16, Na_2O 3·36, K_2O 4·90, H_2O+ 0· H_2O- 0·05, CO_2 0·01, P_2O_5 0·01, F 0·15, less O for F 0·06, total 100·06. M. A. P.

Macpherson (E. O.). *Deposit of barite and fluorspar, Thomson hill, Wangape survey district, Nelson.* New Zealand Journ. Sci. Techn., Sect. B, 1944, v 25, pp. 178–180, 1 fig. (map).

Gage (M.). *Barite deposit near Stockton mine, Ngakawau survey district, Westp district.* Ibid., pp. 181–182, 1 fig. (map).

At Thomson hill veins of baryte, with scattered crystals of fluorite and so

artz, occurs at the junction of hornblendite and Ordovician schists which are ar a granite mass. Analyses show $BaSO_4$ 45·6–64·7, CaF_2 7·8–19·5, SiO_2 18·0–·0 %, &c. Near Stockton mine small veins of baryte occur along parallel joints coal-measures grit. L. J. S.

JNN (J. A.). *Mica.* Rec. Geol. Surv. India, 1942, vol. 76, Bull. Econ. Min., no. 10, ii + 80 pp., 5 pls., 1 text-fig. Price *Rs.* 2–2 or 3*s.* 6*d.*

A good general account of the uses, occurrences, mining, preparation, market-g, statistics, &c., of mica, with special reference to India. Muscovite is mined Bihar, Madras, Rajputana, &c., and phlogopite in Travancore and Madras. har produces 80 % of the world's best-quality sheet mica. L. J. S.

OOKSHANK (H.). *Mica, beryl and columbite-tantalite in Rajputana.* Bull. Imp. Inst. London, 1945, vol. 43, pp. 228–235.

Ruby mica is worked from pegmatites in several areas. Beryl in subordinate nount usually occurs along the quartz cores of the veins, associated with avelandite and some columbite-tantalite. L. J. S.

URDOCK (Thomas G.) & HUNTER (Charles E.). *Mica na região de S^ta Maria do Suassui, Estado de Minas Gerais.* Avulso Divisão de Fomento da Produção Mineral, Brasil, 1944, no. 53, 27 pp., 2 pls., 2 text-figs.

URDOCK (Thomas G.). *Mica no Estado de São Paulo.* Ibid., 1944, no. 54, 30 pp., 3 pls., 2 text-figs.

IYTHE (Donald D.). *Abecedário do prospector de mica.* Ibid., 1944, no. 56, 22 pp., 5 figs.

Details are given of the several quarries in kaolinized pegmatite worked for uscovite. L. J. S.

ILES (Keith R.). *Part I. The blue asbestos bearing banded iron formations of the Hamersley Ranges, Western Australia.* Bull. Geol. Surv. Western Australia, 1942, no. 100, pp. 5–37, 10 figs.

OXALL (J. S.). *Part II. The blue asbestos deposits of the Hamersley Ranges and their economic importance.* Ibid., pp. 38–58, 2 pls. (maps).

The extensive deposits over a wide area are in banded ironstones with jasper, agnetite, haematite, and chalybite. They are very similar to those of South rica [M.A. **4**–92]. Three forms of material are distinguished: 'needle riebeckite', isolated needles up to 1 mm. long scattered through the rock, with β 1·695, $\beta = b$, $c = 2$–$3°$, α deep Prussian blue, β indigo-blue, γ yellowish-green, $\alpha > \beta > \gamma$; 'mass ore riebeckite or potential crocidolite', as radiating aggregates of needles; 'cross ore riebeckite or crocidolite proper', length of fibre up to 2 inches, with the same otical characters as the needles. The chemical composition is discussed and nalyses [M.A. **4**–347] are recalculated to a basis of 24(O,OH,F). L. J. S.

ELENTIEV (B. N.). *Formulae for determining nepheline and pyroxenes in apatite-nepheline ores of the Chibiny tundras.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1944, vol. 44, pp. 378–380, 2 figs.

Plotting the content of apatite against nepheline and against pyroxene gives a

graph of two straight lines. From the determination of P_2O_5 formulae are giv for calculating the percentages of apatite, nepheline, and pyroxene in the ore. L. J. S.

Bushinsky (G. I.). *On a classification of phosphorites.* Compt. Rend. (Dokla Acad. Sci. URSS, 1945, vol. 47, pp. 127–129.

Characters and chemical analyses are given of the different types, and a gen classification is suggested. L. J. S.

Rogers (Austin F.). *Pellet phosphorite from Carmel valley, Monterey Cou California.* California Journ. Mines Geol., Report XL of the State Miner gist, 1944, pp. 411–421, 6 figs.

Thin beds of phosphorite with the appearance of an oolite occur in Monte (Miocene) shale. The buff-coloured grains (0·1–1 mm.) have neither concentric radial structure and are set in a matrix of siliceous shale. The material is isotr pic with n 1·613, and contains 33·11 % P_2O_5 (= 72·33 % $Ca_3P_2O_8$) and about 5 % opal (diatom fragments). It is referred to collophane, which is regarded as an amo phous 'mineraloid' with the composition $3Ca_3(PO_4)_2.nCa(CO_3,F_2,SO_4,O).xH_2O$. The pellets are probably phosphatized micro-coprolites. L. J. S.

Miscellaneous

Franco (R. R.). *Breve noticia sobre a calcita de Botucatú.* Bol. Fac. Fil. Ciên Let. Univ. São Paulo, 1939, no. 18 (Mineralogia no. 3), pp. 45–49, 1 fi (Portuguese with Latin summary.)

Acute scalenohedral (y) crystals of calcite, occurring with celadonite, heula dite, stilbite, mesolite, quartz, and chalcedony in amygdaloidal cavities in augit porphyrite in the Botucatú mountains, São Paulo, show the forms $m\ r\ M\ e\ f$ $d\ y\ t\ \beta\ x$ [Dana's 1892 letters] and O ($26\bar{8}3$). L. J. S.

Mathias (P.). *Nota sobre a columbita de Figueira.* Bol. Fac. Fil. Ciênc. Let. Univ São Paulo, 1939, no. 18 (Mineralogia no. 3), pp. 51–55, 1 fig., 1 folding tabl (Portuguese with Latin summary.)

Goniometric measurements of a crystal of columbite from pegmatite Figüeira, Minas Geraes, showed 14 crystal-forms and gave $a : b : c = 0{\cdot}82882 : 1 : 0{\cdot}88989$. Analyses of other material gave:

Nb_2O_5.	Ta_2O_5.	FeO.	MnO.	UO_2.	Al_2O_3.	SiO_2.	H_2O.	Total.	Sp. gr.
77·07	—	16·56	4·41	2·23	—	0·33	—	'100·68'	5·39
60·92	19·43	13·57	6·16	—	0·15	0·22	0·37	100·82	5·76

Mention is made of other occurrences of columbite in Brazil. L. J. S.

Franco (R. R.). *Piromorfita em Araçariguama.* Bol. Fac. Fil. Ciênc. Let. Univ São Paulo, 1941, no. 21 (Mineralogia no. 4), pp. 33–37, 5 figs. (Portugues with English summary.)

Small, doubly-terminated crystals of yellowish-green pyromorphite occur i veins of auriferous quartz in the old gold-mine of Araçariguama, state of São Paulo. Six crystal-forms are noted. L. J. S.

MARGO (William G. R.). *Nota sobre a baritina de Serrote, estado de São Paulo.* Bol. Fac. Fil. Ciênc. Let. Univ. São Paulo, 1942, no. 30 (Mineralogia no. 5), pp. 25–27, 2 figs. (Portuguese with English summary.)

Colourless to pale yellow or green crystals in massive baryte are tabular on)1). Goniometric measurements are given of six crystal-forms. L. J. S.

MARGO (William G. R.). *Nota sobre a calcita de Pedra do Sino, estado de Minas Gerais.* Bol. Fac. Fil. Ciênc. Let. Univ. São Paulo, 1942, no. 30 (Mineralogia no. 5), pp. 29–34, 4 figs. (Portuguese with English summary.)

Clear crystals of calcite from limestone are of rhombohedral or scalenohedral)it and show ten crystal-forms. L. J. S.

MARGO (William Gerson Rolim de). *Morfologia da wulfenita de Itapirapuan, São Paulo.* Bol. Fac. Fil. Ciênc. Let. Univ. São Paulo, 1945, no. 49 (Mineralogia no. 7), pp. 75–78, 2 figs. (Portuguese with English summary.)

Pyramidal crystals of yellow wulfenite occurring with galena and anglesite wed ten crystal-forms and gave $a:c = 1:1{\cdot}5771$. L. J. S.

RUNK (George C.) & O'DONNELL (H. J.). *Mineral matter in coal.* U.S. Bur. Mines, 1942, Technical Paper 648, 67 pp., 48 figs. Price 15 cents.

Petrographical examination of more than 3000 thin sections of American coals wed the presence of kaolinite, 'iron pyrites' (used as a general term to include ite and marcasite), calcite, quartz, chalybite, and rocks (clay, shale, sandstone). ese are illustrated by numerous good photomicrographs with magnification to 1000. [There is no mention of ankerite, baryte, galena, blende, millerite, &c. n. Mag. **16**–219, **24**–65; M.A. **2**–93, **3**–361, **4**–84, **7**–336, **8**–275.] L. J. S.

N TASSEL (René). *Présence de brushite dans une crypte de l'église Ste-Gudule, à Bruxelles.* Bull. Mus. Hist. Nat. Belgique, 1944, vol. 22, no. 17, 4 pp., 1 fig.

The skull of a person who died in 1633 contains crusts of colourless limpid stals of brushite averaging 0·25–0·5 mm. (up to 1·5 mm.) across, flattened on)) with rhomboidal outline; α 1·543, β 1·548, γ 1·554, $a:\beta = +18°$. L. J. S.

ÁČEK (Radim). *Brushit na kostech z vykopávek na Levém Hradci.* [Brushite on bones from excavations at Levý Hradec.] Věda Přírodní, 1940, vol. 20, pp. 33–35, 2 pls.

he first Bohemian brushite has been found in the old churchyard of Levý dec, north of Praha. Many bones have been entirely changed to a friable regate of minute crystals of brushite. F. S.

ŘEK (Josef). *Nový nález brushitu.* [Newly found brushite.] Věda Přírodní, Praha, 1943, vol. 22, p. 87, 1 fig.

inute rhombic prisms of brushite have been found on about seventy skulls other bones in eighteenth-century tombs in St. James's church at Kutná a, Bohemia. F. S.

Milton (Charles). *Stones from trees.* Scientific Monthly (Amer. Assoc. Ad Sci.), 1944, vol. 59, pp. 421–423, 5 figs.

A large fir tree struck by lightning in Arizona burned for several days, and in t trunk a lava-like mass was found. In thin section this showed platy hexagon crystals of $K_2Ca(CO_3)_2$, formed by the fusion of ash in an atmosphere of C Material of this kind has sometimes been assumed to be meteoritic. L. J. S.

Eckermann (Harry von). *The manganese-chlorite from Långban, some confirm tive data.* Geol. För. Förh. Stockholm, 1944, vol. 66, pp. 721–724, 1 fig.

This mineral [M.A. **3**–474] has been suggested by J. Jakob 1928 [M.A. **4**–2 to be a phlogopite rather than a chlorite. A recalculation of the chemical anal agrees better with the chlorites, and an X-ray powder photograph is iden with one of chlorite and distinct from phlogopite. L. J. S.

Hutton (C. Osborne). *Two unusual occurrences of paraluminite.* New Zea Journ. Sci. Techn., Sect. B, 1945, vol. 26, pp. 242–244.

Colourless needles up to 3 mm. long in cavities in old concrete have α 1·46 β 1·471, γ 1·471, negative elongation, 2V 7–9°, negative. Similar crystals 3–5 long as an efflorescence on deteriorating tuffaceous stone-work have α 1·46 γ 1·470, 2V small, and contain Al, SO_4, H_2O, with some Na. L. J. S.

Rudolph (Joseph). *Über den Schweizer Brookit und seine optischen Anomalie* Schweiz. Min. Petr. Mitt., 1943, vol. 23, pp. 437–466, 48 figs.

Crystals of brookite from the Maderanerthal gave $a:b:c = 0{\cdot}8401:1:0{\cdot}938$ and the new forms (4.10.3) and (9.10.2). Two types of crystals are distinguish according to the distribution of colour and surface markings. Anomalies in t interference colours and figures may be due to a sub-parallel grouping of su individuals or to fine twinning. L. J. S.

Parker (Robert L.). *Ein neues Schweizerisches Hämatitvorkommen.* Viert jahrsschr. Naturfor. Gesell. Zürich, 1943, vol. 88, pp. 149–150, 1 fig.

Small (5 mm.) tabular crystals of haematite from Tessin (precise locality n stated) show the forms *a f* g *m n q r* η *c* [Dana's 1892 letters]. They are compar with well-known larger crystals from the Alpine crevices at Cavradi gorge a Alp Lercheltini. L. J. S.

[Deans (T.).] *Ilmenorutile from Sierra Leone.* Bull. Imp. Inst. London, 19 vol. 42, pp. 45–47.

Grains (5–10 mm.) of ilmenorutile from alluvium near Sakasakala on t Tonkolili river have sp. gr. 4·69–4·80, H. 6. The crushed powder is browni yellow with strong pleochroism, α brownish-yellow, γ bluish-green. Analysis L. C. Chadwick gave TiO_2 55·7, Nb_2O_5 22·6, Ta_2O_5 9·4, FeO 11·0 = 98·7. Mn, Sn(?) not determined. L. J. S.

Vincienne (Henri). *Découverte de minéraux nickélifères dans le filon plomb argentifère de Pontpéan (Ille-et-Vilaine).* Compt. Rend. Acad. Sci. Par 1943, vol. 216, pp. 899–900.

Breithauptite and rammelsbergite occur in calcite. L. J. S.

ENSEL (Percy), med röntgenografisk undersökning av Olov ALVFELDT. *Beryllium-orthit (muromontit) från Skuleboda fältspatbrott.* Arkiv Kemi, Min. Geol., 1945, vol. 18A, no. 22, 17 pp., 3 figs. (English summary, p. 17.) (Separates dated 1944.)

ong needles resembling allanite occur in pegmatite with yttrotantalite, native nuth, and blende in the Skuleboda felspar quarry near Uddevalla in Boküs-län, t coast of Sweden. They show the crystal-forms *c a m e r* [Dana's letters]; ropic with uneven birefringence, mean *n* 1·663. Analysis by T. Berggren , Yt, La–Dy determined spectroscopically by O. Alvfeldt) gave SiO_2 23·96, $_5$ 0·23, TiO_2 0·26, ThO_2 1·03, Al_2O_3 10·84, Fe_2O_3 7·68, Yt_2O_3 6·10, La_2O_3 2·56, O_3 7·66, Pr_2O_3 0·93, Nd_2O_3 4·33, Sm_2O_3 1·13, Gd_2O_3 0·68, Dy_2O_3 0·21, BeO 3·83, 2·43, SrO 0·05, MnO 0·12, FeO 3·00, MgO 0·95, Na_2O 0·59, K_2O 1·98, F 1·92, 8·84, H_2O+ 7·98, H_2O- 0·19, C 0·83 = 100·31, sp. gr. 3·069. Machatschki's nula $X_2Y_3z_3(O,OH,F)$ [M.A. **4**–357] is discussed. X-ray powder photographs w the lines of bastnäsite; after the mineral has been heated to 1000° C. these replaced by those of fluorite and apatite. The mineral is regarded as a decom- ed muromontite. [M.A. **7**–464.] L. J. S.

P (Erland) & ÖDMAN (Olof H.). *On thucholite and natural gas from Boliden.* Årsbok Sveriges Geol. Unders. 1944, vol. 38, no. 6 (Avh. Upps., ser. C, no. 464), 14 pp., 4 pls., 1 text-fig.

xamination of polished sections of thucholite from Boliden, Sweden [M.A. 7], shows it to be a mixture of an anisotropic carbonaceous material and nants of a replaced isotropic uranium mineral (probably uraninite) together h sericite, rutile, pyrite, &c.; and the following new analysis by T. Berggren ws that it is variable in composition: moisture 1·14, S 1·18, ash 30·15, sp. gr. ; the ash gave U_3O_8 39·70, ThO_2 6·24, PbO 4·53, TiO_2 37·26, &c. (including rare-earths determined by X-ray spectroscopy by O. Alvfeldt). TiO_2 is bably present as rutile, and the name 'titano-thucholite' [M.A. **9**–37] seems erfluous. The previous age determinations (517 and 811 million years) are eliable. From that part of the mine where thucholite occurs in andalusite- cite-rock there is an emission of gas; 9 analyses show CH_4 59·6–68·8, N 22·9– , He 2·3–5·3 %. This is compared with natural gas from other localities. It uggested that thucholite has been formed by the polymerization of hydro- ons by radioactive radiation. L. J. S.

DSON (Douglas Rennie). *Gold and silver winning by amalgamation. Part I.—Historical development.* Metallurgica, Manchester, 1944, vol. 29, pp. 255–261, 1 fig. *Part II.—Theoretical.* Ibid., 1944, vol. 29, pp. 299–303, 3 figs. [M.A. **9**–55.]

historical outline is given of the development of mining for gold and silver extraction by amalgamation. A mercury layer $2·2 \times 10^{-4}$ cm. thick imparts reasy surface to gold, and the surface tension causes the particles to stick ether. The resulting amalgam consists of particles of metal immersed in id mercury (which can be squeezed out), and only after prolonged con- with small particles are the compounds Ag_3Hg_4 and $AuHg_2$ formed.

L. J. S.

Caillère (*Mlle* S.). *Sur les caractères spécifiques d'un groupe d'hydrocarbonates magnésiens comprenant la stichtite comme terme chromifère et la brugnatellite (pyroaurite) comme terme ferrifère.* Bull. Soc. Franç. Min., 1943, vol. [illegible] pp. 494–502, 2 pls., 1 text-fig.

Stichtite from Morocco [M.A. **9**–121] agrees in optical data, X-ray pattern, and thermal curves (endothermal breaks at 200° and 440°) with stichtite from Transvaal (α' 1·538, γ' 1·553), brugnatellite from Monte Ramazzo, Italy (α' 1·5[illegible] γ' 1·562), and pyroaurite. The general formula is $9MgO.R_2O_3.2CO_3.18H_2$[illegible] [M.A. **8**–51, 99.] L. J. S.

Sahama (Th. G.). *Abundance relation of fluorite and sellaite in rocks.* Ann. Acad. Sci. Fennicae, 1945, ser. A, III Geol. Geogr., no. 9, 20 pp., 2 figs.

From specific heats and heats of formation curves are constructed of the stability relations of fluorite and sellaite (MgF_2) in anhydrite and calcite. The rarity of occurrences of sellaite (in anhydrite, limestone, and dolomite [M.A. **5**–238]) is commented upon; it cannot occur in siliceous rocks. L. J. S.

Fowler (A.). *On fluorite and other minerals in Lower Permian rocks of south Durham.* Geol. Mag. Hertford, 1943, vol. 80, pp. 41–51, 1 fig.

Magnesian Limestone from bore-holes at Fishburn contains small geodes with crystals of calcite, fluorite, some baryte, and little galena, pyrite, and blende. The fluorite, present in quantity in one stratum, is colourless, yellow, violet, brown, or black, and of various forms: platy; small cubes; skeletal octahedra with platy septa parallel to cube faces forming triangular hoppers; white, powdery; compact and horny. L. J. S.

Dartevelle (Edm.). *Fulgurites du Congo.* Bull. Soc. Belge Géol. Bruxelles, 1942, vol. 50 (for 1940–1941), pp. 91–95, 2 figs. [M.A. **9**–104.]

Fragments of fulgurites have been found on the surface of sand near Loango (4° 40′ S., 11° 50′ E.) in Middle Congo, French Equatorial Africa. L. J. S.

Scholz (A.) & Strunz (H.). *Identität von Kreuzbergit und Fluellit.* Zentralbla[illegible] Min. Geol., Abt. A, 1940, pp. 133–137.

Crystals found with triplite in the phosphate-bearing pegmatite of Hagendorf, Bavaria, are identified with fluellite and kreuzbergite [M.A. **1**–125, **2**–47?]. They have $a:b:c = 0{\cdot}7724:1:1{\cdot}8715$, α 1·490, β 1·496, γ 1·509, 2V large, and give the same X-ray pattern as fluellite from Stenna Gwyn, Cornwall (α 1·475, β 1·49[illegible] γ 1·510). Microchemical tests show no phosphate. L. J. S.

Obruchev (V. A.) & Grigoriev (D. P.). *Native magnetic gold.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1945, vol. 46, pp. 290–292, 1 fig.

Small, dull flakes of gold from Yakutsk district are magnetic with polarity, the susceptibility ($\chi = 0{\cdot}040$ C.G.S. μ_0) being between that of pyrrhotine and ilmenite. Analysis by K. A. Nenadkevich gave Au 78·24, Ag 17·23, Fe 4·4 %. This composition falls on the boundary of the $AuFe_3$ field in the system Au–Fe.

L. J. S.

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